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DARLINGTON LARVAL FISH AND EGG INCUBATION STUDIES 1985 TO 1988

Report No 90-19-K

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ABSTRACT

Larval fish studies during the 1985-88 period included annual spring sampling for round whitefish larvae, entrainment sampling at the intake site from April to August of 1986, and a round whitefish egg incubation study over the 1986-87 winter. Catches of round whitefish larvae were very low in 1985 (8) and 1986 (5). Numbers increased in 1987 (12) and 1988 (43). The increase was attributed to greater use of the benthic sled, concentrated sampling during late April and early May, night sampling (started in 1987) and doubling tow length (1988). Of 68 larvae caught, 38 were at 5 m depth, 15 were at 7 m, and 13 were at 10 m. Fifty-six were from diffuser sites and 12 were from intake sites. In 1986 entrainment samples, smelt larvae were first collected on June 3, peaking on June 17 and July 7-14. In other years, smelt larvae were usually present in mid to late May. Alewife larvae (present July 22 to August 14) showed peak catches on July 22 and July 31. Round whitefish eggs placed in incubators at 4 sites on December 16, 1986 had completed hatch by April 13, 1987. Survival declined to 56.8% on April 7, then dropped to 17.4% on April 13. Laboratory thermal models predicted much lower mortality than observed. This "excess mortality" was significantly correlated with fine sediments which accumulated in the incubators. Use of the thermal models plus the "excess mortality" correction resulted in good correspondence with observed survival. This approach is an important first step in quantifying effects of temperature and sedimentation on egg survival in the field.

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EXECUTIVE SUMMARY

DARLINGTON LARVAL FISH AND EGG INCUBATION STUDIES 1985 TO 1988

J.S. Griffiths

Studies to assess effects of Darlington NGS on the reproduction of cold-water fish species have been an important component of preoperational aquatic studies over the 1984-1988 period. Potential effects of the generating station on reproduction of round whitefish have been a primary concern. This fall spawning species, whose eggs normally hatch in the spring, has extremely stringent temperature requirements for egg development. Our gill net sampling indicates that adults are very abundant near the discharge diffuser during the December spawning period.

Spring sampling for round whitefish larvae was conducted in the vicinity of the discharge diffuser and the condenser cooling water (CCW) intake from 1985 to 1988. Sampling with paired 0.5 m tow nets (surface and mid-depth) and the benthic sled was conducted from mid-April to late May. In 1985, eight larvae were captured in 438 samples. In 1986, five larvae were collected from 484 samples. The 1987 catch was 12 larvae (from 348 samples), while in 1988, 174 samples yielded 43 larvae. The increased catch was attributed to increased emphasis on the benthic sled, concentration of effort during the late-April to early-May period, sampling at night with the benthic sled (started in 1987), and increasing tow length from 300 m to 600 m (begun in 1988). Of the 68 round whitefish larvae captured, 61 were collected from bottom tows with the benthic sled, two were in mid-depth tows and 5 were in surface tows. Future sampling should concentrate on use of the sled, although surface tows (which can be done concurrently) should be continued to determine if larvae are being displaced offshore by diffuser currents. It is recommended that mid-depth towing be discontinued.

Most larvae (38) were captured at the 5 m sampling depth. Catches were moderate at 7 m depth (15 fish) and 10 m depth (13 fish). Only a single larva was collected at each of the 12 m and 15 m sampling depths. In future studies, it is suggested that some sampling be done inshore of 5 m to determine whether the 5 m catch represents the peak abundance. While continued sampling at 15 m is not recommended, the 12 m location in the discharge area should be sampled to determine whether offshore displacement of larvae is occurring. The larval catch at the diffuser site (56) was much greater than the intake catch (12 larvae), an observation in agreement with high adult catches near the inshore end of the diffuser during the spawning period. As high adult catches have also been observed at the west reference fishing site, it is suggested that future sampling should consider this location to provide a reference site for round whitefish larval sampling.

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Larval drift nets were operated during 1987 at the intake location in depths of 5 m and 7 m from April 23 to May 22. No round whitefish larvae were collected. Operation of these traps at the diffuser locations (5 m and 7 m) during 1988 (April 29 to May 17) resulted in the catch of only one round whitefish larva. Thus, it is concluded that these nets are not suitable for collection of larvae in the open lake environment. However, they may prove useful in areas of higher current.

Assessment of larval fish entrainment by the CCW system is also part of the Darlington aquatic study. During the preoperational phase, larval fish samples were collected twice per week from mid-April to mid-August, 1986, in the vicinity of the intake. Rainbow smelt larvae were first collected on June 3, with peak abundance occurring on June 17. A second, smaller abundance peak was observed over the July 7 to July 14 period. Smelt larvae were most abundant in surface samples, but also occurred in mid-depth and bottom samples. Spring tow net and sled sampling done in other years indicated that smelt larvae are usually present during the second and third weeks of May.

During 1986 entrainment sampling, alewife larvae were collected from July 22 to August 14. Peak catches in surface nets occurred on July 22 and August 31. Bottom catches peaked on August 5-6 and were only about 1/3 the size of surface catches. Alewife catches were about an order of magnitude larger than the catches of smelt larvae.

Several other species of larval fish were collected during spring tow netting and the 1986 entrainment sampling, and may be occasionally entrained by the Darlington CCW intake. These include white sucker, carp and yellow perch. Large catches of juvenile and adult sculpins in sled tows (mostly in 1987-88) suggest that some sculpins may also be entrained by the intake.

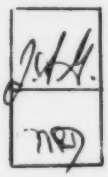
During the winter of 1986-87, field incubation studies were conducted with round whitefish eggs at four locations to obtain preoperational data. The study will be repeated at 2-unit and 4-unit levels of operation to assess effects of the station on round whitefish hatch times and egg survival. Round whitefish eggs were fertilized and placed in incubators at four sites on December 16, 1986. Eggs were sampled on five occasions until completion of hatch on April 13, 1987. As incubation progressed, egg survival gradually declined to an average value of 56.8% on April 7, when hatch was just beginning. Over the hatching period, survival decreased dramatically, to an average of 17.4% on April 13. Mortalities included both dead eggs and substantial numbers of larvae which died after hatch.

Expected egg development and survival were predicted from laboratory thermal models, using temperatures recorded by thermographs near the egg incubators. Predicted development lagged behind observed development during the early portion of the incubation period. By the start of hatch (stage 19) on April 7, predicted development closely coincided with observed results. Hatch then occurred within one week, much faster than predicted. Previous studies at Pickering have suggested that the predicted date for 50% hatch (stage 19.5) closely coincided with observed hatch dates (within 2.3 days). At Darlington, hatch was nearly complete about 7 days before the predicted date for 50% hatch. Predicted survival followed a pattern similar to observed results (moderate early mortality, low mortality during the middle development period, and sharply increased mortality at hatch). However, predicted survivals were substantially higher than observed results.

Sediment accumulation in the incubation chambers increased steadily throughout the incubation period. The accumulation of fine materials showed a very sharp rise over the last two weeks of incubation. The "excess mortality" values (difference between observed values and those predicted from the thermal models) were regressed against various size fractions of the sediments. The best correlation was obtained for the finest sediments (those less than 38 microns diameter).

A new set of survival curves was then "predicted" by a two-step process. At each sampling date, the survival value predicted from the thermal models was adjusted, using the "excess mortality" regression and the observed sedimentation value. This corrected "prediction" closely corresponded with observed survival results.

The predictive value of the method developed in this study will be tested on a new egg incubation data set obtained when Darlington becomes operational. Additional data will also be obtained to correlate sediment accumulation within the incubators to sediment collection tube data. This should allow a realistic quantitative assessment of sedimentation effects on round whitefish egg survival, including local variations (possibly modified by station diffuser currents) and year-to-year variations (resulting from differences in weather).



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DARLINGTON LARVAL FISH AND EGG INCUBATION STUDIES - 1985 TO 1988

1.0 INTRODUCTION

Studies to assess effects of Darlington NGS on the reproduction of cold-water fish species have been an important component of the preoperational aquatic studies over the 1984-1988 period. Of primary concern have been the potential effects of the generating station on round whitefish reproduction. This fall-spawning species, whose eggs normally hatch in spring (early-mid April) has been shown to have extremely stringent temperature requirements for egg development (OHRD Report 80-140-K).

While eggs exposed to small temperature elevations from discharge heating might experience some increased mortality if temperature increases exceed 3°C, the greatest adverse effect is expected from advancement of hatching times, resulting in asynchrony of whitefish larvae and their early food supplies (OHRD Report 80-140-K, Greig et al, 1984). In simulation models developed during the 1984 Darlington workshop, it was assumed that advanced hatch would increase larval mortality through starvation, with total mortality occurring for hatch advances exceeding 30 days (Greig et al, 1984). Such hatch advances would be expected for eggs subjected to continuous temperature increases exceeding 1.5°C (OHRD Report 80-140-K).

During the preoperational monitoring period, spring sampling was conducted for round whitefish larvae from 1985 to 1988. Samples were collected from approximately mid-April to mid-May in the vicinity of the discharge diffuser and the CCW intake, at depths from 5 to 15 m. Surface and mid-water samples were collected with paired 0.5 m tow nets, and a benthic sled (with paired 0.5 m nets) was used to collect bottom samples.

During the winter of 1986-87, field incubation studies were conducted with round whitefish eggs at four locations to obtain preoperational data. Once Darlington begins operation, additional egg incubation studies are planned (at 2 unit and four unit levels of operation) to assess effects of the station on round whitefish hatch times and egg survival. Placement of thermographs at the egg incubation sites will allow comparison of observed egg development and predictions based on laboratory models (OHRD Report 80-140-K).

Assessment of larval fish entrainment by the CCW system is also part of the Darlington aquatic study. During the preoperational phase, ichthyoplankton samples were collected twice per week from mid-April to mid-August, 1986, in the vicinity of the CCW intake. Samples were collected with paired tow nets (300 m tows) taken at the surface, mid-depth and near bottom.

2.0 METHODS

2.1 Spring Sampling For Round Whitefish Larvae

2.1.1 Tow Net And Benthic Sled Sampling

Spring sampling for round whitefish larvae was conducted in the vicinity of both the CCW intake and the discharge diffuser over the 1985-1988 period. Paired 0.5 m diameter tow nets (243 micron mesh) were used for surface and midwater samples, and a benthic sled (equipped with similar nets) was used for bottom samples.

At the intake and discharge sites, surface, midwater and bottom tows were made at the 5, 7, 10, 12, and 15 m contours during 1985 and 1986 (Figure 1). Sampling at the 15 m depth contour was discontinued after 1986, as very few larvae were collected in these off-shore samples. Tows were made parallel to shore at a speed approximating 1 m/s for 5 minutes, and approximated 300 m in length (Figure 1).

In order to improve our sampling success, tow lengths were increased to 600 m in 1988 (Figure 2). During 1988, tow lengths were determined from Loran C coordinates. This approach appeared to yield consistent tow lengths. Other modifications to the sampling program designed to improve our sampling success were a shift to night sampling and increased emphasis on benthic sled sampling. During 1985 and 1986, surface and midwater tows were done at night, but benthic sled sampling was done during the day. Tests made with a 1/3 scale model sled in a laboratory flume indicated that in darkness, round whitefish larvae rose slightly off the bottom and became more vulnerable to capture by the sled (OHRD Report 88-334-K). Therefore, in 1987 and 1988, all larval fish sampling was done after dark. During the 1985-1987 sampling periods, surface and midwater tows were made twice per week at each location, and benthic sled tows were made once per week. As most round whitefish larvae were collected by the benthic sled during this period, the 1988 sampling schedule was modified to better utilize the more effective gear. Accordingly, in 1988, two sled tows were made per week at each site, while surface and midwater tows were reduced to one per week at each site. While the total number of sled tows in 1988 was comparable to previous years, the 1988 tows were concentrated in the most productive time period (from late April to early May).

2.1.2 Larval Drift Net Sampling

Tests conducted during the laboratory benthic sled studies (OHRD Report 88-334-K) suggested that round whitefish larvae might be vulnerable to capture by stationary 'drift' nets oriented into the current flow. Therefore, nets were constructed and tested during the mid-April to mid-May period in 1987 and 1988.

The drift nets were a relatively simple modification of the 0.5 meter tow nets used for surface and midwater tows. A steel frame was constructed to form the net opening (Figure 3). The net frame (50 cm wide x 25 cm high) was attached to a 1.5 cm thick base plate (30 cm x 50 cm) which formed the entrance to the net and provided the weight necessary to keep the net entrance on bottom. In addition, anchors were attached to the front and rear of the net (Figure 3) to prevent movement by strong currents or waves.

A special trap was constructed to replace the collection buckets normally used with these nets (Figure 4). It was constructed of 10 cm diameter clear PVC pipe and PVC plumbing adaptors. A tapered cone with a 1.5 cm diameter opening formed the entrance to the trap to reduce the likelihood of escape by captured larvae. The plumbing fitting at the rear of the trap was screened with 243 micron mesh to allow free current flow through the trap.

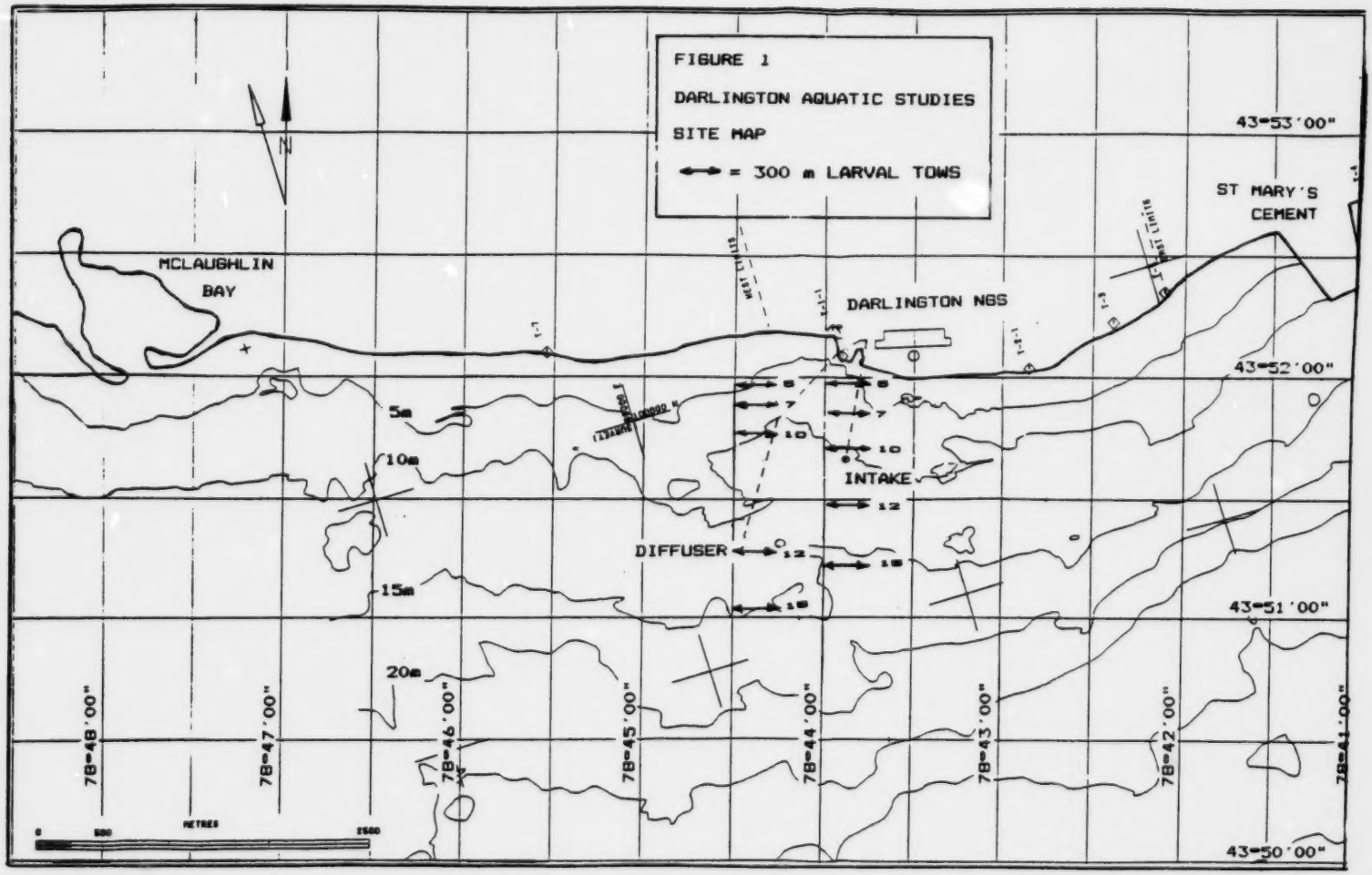


FIGURE 1
DARLINGTON AQUATIC STUDIES
SITE MAP
= 300 m LARVAL TOWS
N
MCLAUGHLIN BAY
DARLINGTON NGS
ST MARY'S CEMENT
INTAKE
DIFFUSER
5m
10m
15m
20m
43°53'00"
43°52'00"
43°51'00"
43°50'00"
78°48'00"
78°47'00"
78°46'00"
78°45'00"
78°44'00"
78°43'00"
78°42'00"
78°41'00"
METRES

FIGURE 2
DARLINGTON AQUATIC STUDIES
SITE MAP
= 600 m LARVAL TOWS
ST MARY'S CEMENT
DARLINGTON NGS
INTAKE
DIFFUSER
MCLAUGHLIN BAY
43°53'00"
43°52'00"
43°51'00"
43°50'00"
78°41'00"
78°42'00"
78°43'00"
78°44'00"
78°45'00"
78°46'00"
78°47'00"
78°48'00"
5m
10m
15m
20m
N
METRES

FIGURE 3
DRIFT NET FOR SAMPLING
ROUND WHITEFISH LARVAE

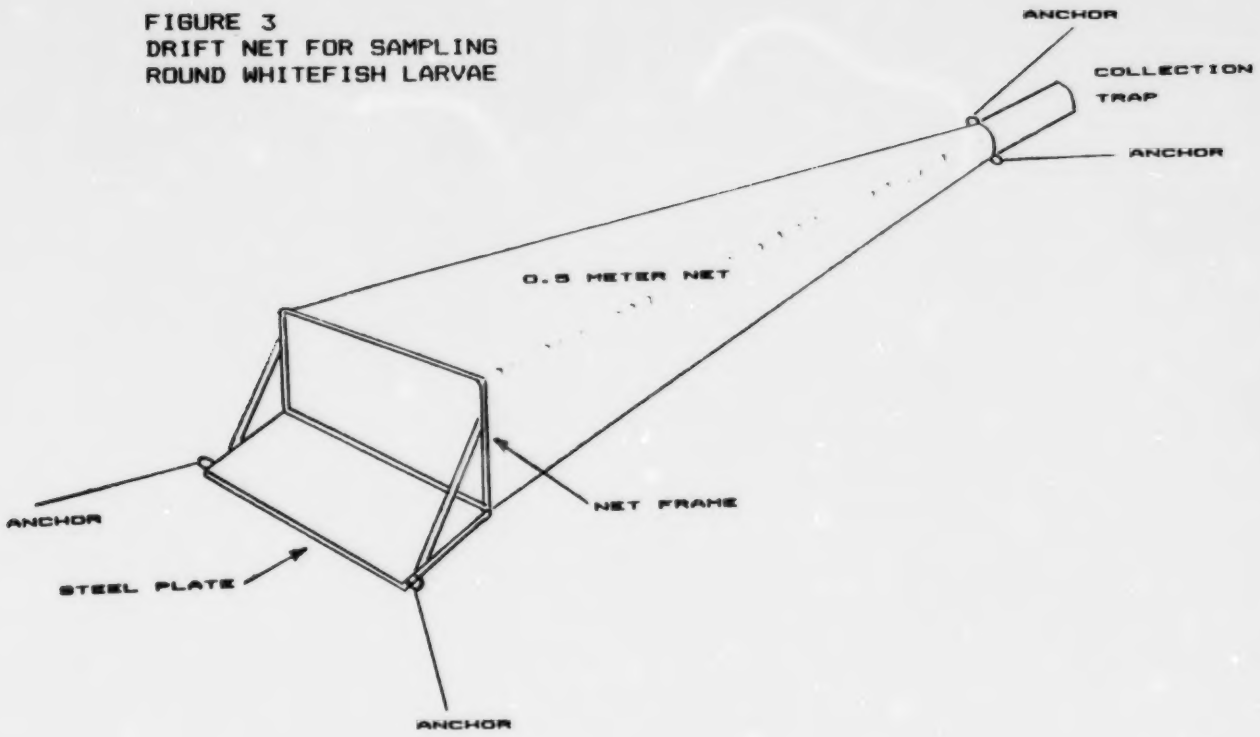
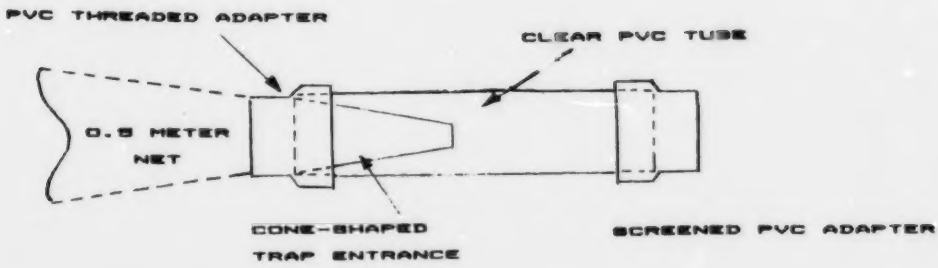


FIGURE 4
DETAILS OF COLLECTION TRAP



The nets were placed on the bottom by divers. Relatively smooth sampling locations were selected to allow the net entrance to sit flush with the bottom. Nets were oriented to sample the long-shore currents (parallel to shore) and at each sample site, two nets were set, one facing west and one facing east. During 1987, the nets were placed inshore from the CCW intake at 5 m and 7 m depths (two nets at each depth). During 1988, the nets were placed at similar depths inshore of the discharge diffuser.

During sample collection, the nets were left in place, and divers simply replaced the trap with a new unit. The trap was then capped to prevent escape of captured larvae, and the contents were washed into a collection jar aboard ship. During the mid-April to mid-May sampling period, the drift nets were usually serviced by divers twice per week.

Initial samples collected in 1987 indicated that some sculpins were entering the traps. As it was suspected that sculpins might eat captured round whitefish larvae, the entrance to the traps was screened with 1 cm square wire mesh to reduce capture of larger sculpins.

2.2 Larval Fish Entrainment Sampling

Preoperational sampling of larval fish was conducted in 1986 to provide baseline data for future intake entrainment studies which will be conducted once Darlington becomes operational. The 1986 samples were collected with paired 0.5 m nets (243 micron mesh) towed in the intake vicinity at the surface, mid-depth and near bottom. As with round whitefish sampling, tows were approximately 300 m in length and parallel to shore. All tows were made after dark. Tow net samples were collected at the intake twice per week from mid-April to mid-August.

2.3 Round Whitefish Egg Incubation Study

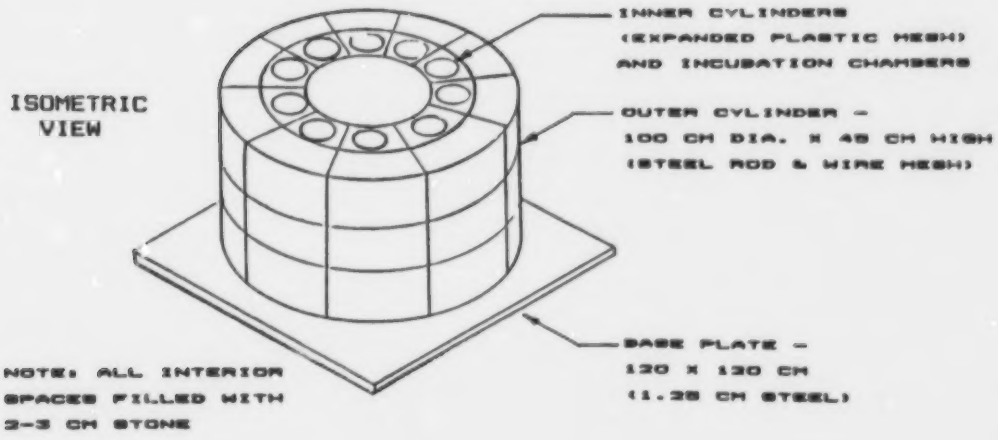
A field incubation study using round whitefish eggs was conducted at Darlington over the winter of 1986-1987. As detailed temperature data were collected from recording thermographs located near the egg incubators (OH Design & Development Division Report 88283), results can be used to verify predictions made from laboratory models (Greig et al, 1984; OHRD Report 80-140-K). This study also provides baseline information which will be compared with results of similar studies to be conducted during the commissioning phase of Darlington (2 unit operation) and once the station becomes fully operational (4 unit operation). In addition, data may be compared with field incubation results obtained from the Pickering area over the winter of 1984-1985 (OHRD Report 87-181-K).

The egg incubators constructed for the Pickering study were re-used at Darlington. Each incubator consisted of a 100 cm diameter x 45 cm high cylindrical wire cage attached to a 120 cm square x 1.25 cm thick steel base plate (Figure 5). Each incubator contained ten incubation baskets, made of stainless wire (1 mm mesh) and PVC plastic. These egg baskets were supported about 10 cm above the base plate by circular columns of wire and PVC mesh. All areas within the incubator (including the egg baskets) were filled with 2 to 3 cm gravel. Once filled with gravel, the incubators were very heavy, and resistant to the wave forces of winter storms. The substantial mass of gravel surrounding the eggs was also expected to reduce the damaging effects of wave forces on the eggs, yet allow sufficient water movement for respiratory exchange.

As this was a preoperational study, with only minor temperature differences expected between sites, only four egg incubators were used. Incubators were placed at 7-8 meters depth near the west reference gill net fishing area, directly inshore from the diffuser line, and near the east reference fishing area (Figure 6). The fourth incubator was placed near the offshore end of the diffuser on a cobble and boulder ridge at 10 meters depth. This location, near substrate monitoring site #9, has a clean substrate and due to its position (Figure 6) appears to be exposed

FIGURE 5

ROUND WHITEFISH EGG FIELD INCUBATOR


ISOMETRIC VIEW
INNER CYLINDERS (EXPANDED PLASTIC MESH) AND INCUBATION CHAMBERS
OUTER CYLINDER - 100 CM DIA. X 45 CM HIGH (STEEL ROD & WIRE MESH)
BASE PLATE - 120 X 120 CM (1.25 CM STEEL)
NOTE: ALL INTERIOR SPACES FILLED WITH 2-3 CM STONE

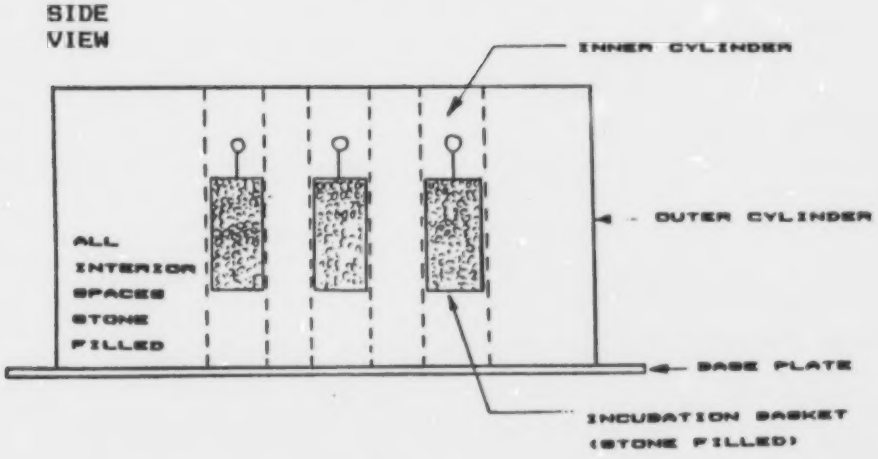


FIGURE 6
DARLINGTON AQUATIC STUDIES
SITE MAP
= EGG INCUBATOR LOCATIONS
= THERMOGRAPH LOCATIONS
PORT DARLINGTON
ST MARY'S CEMENT
DARLINGTON NGS
INTAKE
DIFFUSER
MCLAUGHLIN BAY
43°53'00"
43°52'00"
43°51'00"
43°50'00"
78°40'00"
78°41'00"
78°42'00"
78°43'00"
78°44'00"
78°45'00"
78°46'00"
78°47'00"
78°48'00"
5m
10m
15m
20m

to long-shore currents. Thus it was expected to be a suitable site for round whitefish egg incubation.

The egg incubators were installed at the four sites and filled with clean cobble during November, 1986. Each site was marked with a spar buoy. Round whitefish eggs for the incubation study were obtained from fish captured during gill net sampling on December 16, 1986. A large catch at the inshore end of the diffuser provided an ample supply of fully ripe adults for spawning. Eggs were stripped and fertilized in the field. Eggs from 10 to 12 females were fertilized with milt from 6 to 8 males. The fertilized eggs were thoroughly mixed prior to being added to the incubation baskets. The egg baskets (1 mm stainless mesh) were filled with 2 to 3 cm stone and submerged in a bucket. Then, 150 eggs were added to each basket. Gentle agitation allowed the eggs to percolate down into the substrate before the baskets were sealed and placed into the the incubation chambers on the lake bottom. After the egg chambers were lowered into the channels in the incubator, several centimeters of gravel were added above the egg chambers. Eggs were added to all four incubators (40 egg chambers) on December 16. After fertilization, during the process of counting and addition of the eggs to the chambers, eggs were kept in cold water. As air temperatures were near freezing on December 16, it is unlikely that eggs experienced temperatures more than about 3°C. Lake bottom temperatures at the incubation sites were in the 2.4 to 2.8°C range on the day of fertilization.

A sample of eggs was returned to the laboratory and incubated at ambient lake temperatures. Examination of these eggs over the next several days indicated that fertilization success approximated 100%.

Developing eggs were sampled from the incubators on 5 occasions during the winter and early spring of 1987. The first sampling date was January 20, 1987. Eggs were not sampled earlier in order to allow development past the early stages which are sensitive to handling (OHRD Report 80-140-K, Johnson et al, 1989). The second set of egg samples was collected on February 16, after 62 days of incubation. The remaining three samples from each incubator were collected on March 24, April 7, and April 13, 1987. These last 3 sampling periods were timed to be near the end of embryonic development to provide good estimates of survival at hatch.

On each sampling occasion, divers removed two egg chambers (selected at random) from each incubator. These were carefully placed in a bucket (two chambers/bucket) and lifted to the surface. The egg chambers remained in the buckets for transport to the laboratory, where they were held overnight in a water bath at lake ambient temperature. The following day, the chambers were opened and the eggs were carefully removed from the gravel substrate. The eggs were examined with a dissecting microscope to determine the stage of development, using the 20 developmental stages recognized in previous studies (OHRD Report No 80-140-K). Development stage of eggs from each replicate chamber was determined separately from examination of 5-10 eggs. Where differences in development were observed for replicate chambers, an average value was computed. A count of live eggs and larvae was made for each chamber and any dead eggs or larvae were enumerated. In the initial set of samples (January 20), the total of live eggs plus dead eggs was taken as the starting egg number for each chamber in percentage survival calculations. However, due to rapid decomposition of dead eggs and larvae, this approach was not possible in subsequent samples. In these later samples, live eggs and larvae were counted and it was assumed that the starting egg number for each chamber was 150 eggs.

As the Pickering field incubation study (OHRD Report No 87-181-K) suggested that sediment accumulation in the incubators adversely affected egg survival, the amount of accumulated sediment in the chambers was quantified in the present study. After removal of eggs and larvae, the stones from each incubation chamber were cleaned in a tray and the accumulated sediment was recovered. However, it was noted from the first set of samples that a substantial portion of

the fine sediments were washed out of the chambers during the recovery and transport procedures. These sediments remained in the buckets used for chamber recovery and transport. As both replicate chambers were collected in a single bucket, it was necessary to combine all sediments (those from the chambers plus those in the bucket) to obtain a single sediment accumulation estimate for each egg incubator on each sampling date. The accumulated sediments were screened to obtain particle size data, using mesh sizes from 38 microns to 500 microns. Particles which would not pass through a 1000 micron screen were discarded, as it was assumed that such particles did not infiltrate the egg chamber screening (1000 micron) but probably originated from the cobble substrate inside the egg chambers.

3.0 RESULTS AND DISCUSSION

3.1 Spring Sampling For Round Whitefish Larvae

3.1.1 Yearly Catch Summaries

During 1985, larval fish sampling was conducted at the intake and discharge locations over the April 17 to May 23 period. Detailed results are listed in Appendix 1 and results are summarized in Table 1. A total of 438 larval fish samples (219 paired tows) was collected, with approximately equal effort in the intake and discharge areas. There were 156 surface samples, 142 mid-depth samples and 140 bottom samples.

A total of eight round whitefish larvae were collected from April 17 to April 26, 1985. Five were in bottom tows, at depths of 5 m, 7 m (2 larvae), 10 m and 15 m (Table 1). Discharge sampling locations accounted for 5 of the larvae captured and three round whitefish larvae were collected from the intake sampling locations.

In 1986, a total of 484 larval fish samples were collected during the spring sampling over the April 17 to May 27 period (Appendix 2, Table 1). Two hundred samples were taken in surface nets, 184 in mid-depth nets, and 100 samples were collected with the benthic sled. Five round whitefish larvae were captured over the April 23 to May 8 period. Four larvae were collected from discharge sampling sites. Two were in bottom tows (5 m and 10 m), while two were in surface samples (at the 10 m contour). The only round whitefish larva captured at the intake sites during 1986 was collected from a mid-depth tow at the 5 m site (Table 1). Equal numbers of samples were collected at the intake and discharge locations (242 samples at each site).

During 1987, a total of 348 larval fish samples was collected over the April 21 to May 21 period. Detailed results are listed in Appendix 3. Of these samples, 182 were collected in the intake area and 166 were collected in the discharge area (Table 1). Surface tows accounted for 136 samples, mid-depth tows accounted for 116 samples, and 96 samples were collected from bottom locations with the benthic sled.

Twelve round whitefish larvae were collected during the April 23 to May 21 period of 1987. All were collected in bottom tows at the discharge sites. Nine larvae were collected from 5 m depth, two were at 7 m and one was collected from 10 m depth (Table 1).

In 1988, sampling concentrated on the late April to early May period which had produced most larvae in earlier years. Over the April 21 to May 10 period of 1988, a total of 174 samples was collected. There were 54 surface samples, 30 mid-depth samples and 90 bottom samples collected in this period. Eighty-four samples were from intake locations and ninety were from discharge locations (Table 1). In 1988, tow length was doubled (to 600 m).

TABLE 1

SUMMARY OF SAMPLING RESULTS FOR ROUND WHITEFISH LARVAE

1985

Depth Sampled	Intake Samples	RWF Larv	Discharge Samples	RWF Larv	Total Samples	Total RWF
5 m Surf	16	0	16	0	32	0
5 m Mid	14	0	14	1	28	1
5 m Bot	14	0	14	1	28	1
7 m Surf	16	0	16	0	32	0
7 m Mid	14	0	14	0	28	0
7 m Bot	14	0	14	2	28	2
10 m Surf	16	1	16	0	32	1
10 m Mid	16	0	14	0	30	0
10 m Bot	14	1	14	0	28	1
12 m Surf	14	0	16	1	30	1
12 m Mid	14	0	14	0	28	0
12 m Bot	14	0	14	0	28	0
15 m Surf	14	0	16	0	30	0
15 m Mid	14	0	14	0	28	0
15 m Bot	14	1	14	0	20	1
TOTALS	218	3	220	5	438	8

1986

Depth Sampled	Intake Samples	RWF Larv	Discharge Samples	RWF Larv	Total Samples	Total RWF
5 m Surf	20	0	20	0	40	0
5 m Mid	18	1	20	0	38	1
5 m Bot	10	0	10	1	20	1
7 m Surf	20	0	20	0	40	0
7 m Mid	18	0	18	0	36	0
7 m Bot	10	0	10	0	20	0
10 m Surf	20	0	20	2	40	2
10 m Mid	18	0	18	0	36	0
10 m Bot	10	0	10	1	20	1
12 m Surf	20	0	20	0	40	0
12 m Mid	18	0	18	0	36	0
12 m Bot	10	0	10	0	20	0
15 m Surf	20	0	20	0	40	0
15 m Mid	20	0	18	0	38	0
15 m Bot	10	0	10	0	20	0
TOTALS	242	1	242	4	484	5

TABLE 1 (cont'd)

SUMMARY OF SAMPLING RESULTS FOR ROUND WHITEFISH LARVAE

1987

Depth Sampled	Intake Samples	RWF Larv	Discharge Samples	RWF Larv	Total Samples	Total RWF
5 m Surf	18	0	16	0	34	0
5 m Mid	16	0	12	0	28	0
5 m Bot	12	0	12	9	24	9
7 m Surf	18	0	16	0	34	0
7 m Mid	14	0	14	0	28	0
7 m Bot	12	0	12	2	24	2
10 m Surf	18	0	14	0	32	0
10 m Mid	16	0	12	0	28	0
10 m Bot	12	0	12	1	24	1
12 m Surf	18	0	18	0	36	0
12 m Mid	16	0	16	0	32	0
12 m Bot	12	0	12	0	24	0
TOTALS	182	0	166	12	348	12

1988

Depth Sampled	Intake Samples	RWF Larv	Discharge Samples	RWF Larv	Total Samples	Total RWF
5 m Surf	6	0	6	0	12	0
5 m Mid	4	0	4	0	8	0
5 m Bot	10	7	10	18	20	25
7 m Surf	8	0	6	0	14	0
7 m Mid	2	0	4	0	6	0
7 m Bot	10	0	12	11	22	11
10 m Surf	8	1	6	0	14	1
10 m Mid	4	0	4	0	8	0
10 m Bot	10	0	14	6	24	6
12 m Surf	8	0	6	0	14	0
12 m Mid	4	0	4	0	8	0
12 m Bot	10	0	14	0	24	0
TOTALS	84	8	90	35	174	43

The catch of round whitefish larvae in 1988 totaled 43 fish. The increased catch was likely the result of several factors, including night sampling (started in 1987), increased emphasis on the benthic sled, increased tow length, and concentration of sampling during the late-April to early-May period. While the total number of sled samples was slightly less than in previous years, the 1988 sled samples were all taken during the productive late-April to early-May period. Only 8 of the larvae collected in 1988 were taken from intake locations. Seven of these were in 5 m bottom tows and one was taken in a surface tow at 10 meters. At the discharge sites, all 35 larvae were collected in bottom (sled) tows; 18 at 5 m, 11 at 7 m and 6 at 10 m depth.

3.1.2 Timing and Location of Catch

Over the four sampling years, a total of 68 round whitefish larvae were collected between April 17 and May 21. Most of these were taken over the April 21 to May 4 period (Figure 7). From 9-10 larvae were collected each day on April 23, April 28, May 2 and May 4. Few larvae were collected after May 5 (only 3 larvae in total from May 6 to May 21). While sampling did not extend beyond May 10 during 1988, sampling in earlier years (294 samples between May 11 and May 21) yielded only 1 round whitefish larva, indicating few larvae were available for capture (or were vulnerable to our sampling gear) during this period. The catches of round whitefish larvae taken in early May (Figure 7) from 1986 to 1988 were not observed in earlier sampling. In 1985 at Darlington, and both 1984 and 1985 at Thickson Point, east of Pickering, all (of 20) larvae collected were taken between April 17 and April 26 (OHRD Reports 87-181-K; 89-166-K).

Catch data in Figure 7 have considered only total numbers of larvae caught. In Figure 8, data are presented on catch per unit effort (CUE), considering the number of net tows made on each sampling date. All tows are considered (surface, mid-depth, bottom sleds) in Figure 8A. In this plot, data points are shown only for days when sampling was done. Zero values in the figure indicate days when sampling yielded no larvae. Considering all samples (surface, mid-depth, bottom), larval CUE ranged from 0.01 to 0.1 fish/net over the April 17 to April 25 period, then rose to 0.19/net on April 28 (Figure 8A). A second major peak in catch (0.12 to 0.27/net) was observed from May 2 to May 5, and catch was minimal thereafter. If only the sled tows are considered, CUE values are substantially higher (Figure 8B). However, both Figures 8A and 8B do not consider the fact that tow lengths were doubled in 1988. In Figure 8C, results have been computed for a "standard" 300 meter tow; that is, each of the 1988 samples (except the April 21 tows which were 300 m) have been considered as two samples. This results in a reduction by half of the peak CUE value on May 4, and moderate reductions in CUE values for April 26, April 28, and May 2 (Figure 8C). As attached to the benthic sled, the sample nets were approximately 0.5 m wide. Thus, approximately 150 square meters of bottom would be sampled by each net in a 300 m tow. The peak catch on May 4 (0.7 larvae per net) is equivalent to a catch of 0.47 larvae /100 m^2.

The mean lengths of round whitefish larvae are plotted for each sample date in Figure 9. The average length for larvae captured between April 17 and April 26 was about 13 mm. Based on newly hatched larvae in laboratory and field incubations, a length of 12 to 13 mm is expected within a few days of hatch. Larvae captured between April 28 and May 5 averaged about 17 mm in total length (range 14 mm to 20 mm). The two small larvae captured on May 8 and May 10 (14 mm and 13 mm, respectively) probably hatched somewhat later than the other larvae sampled. The larva collected on May 21 (24 mm in length) is the largest round whitefish larva captured at Darlington. At this time, most larvae have either left the sampling area or are able to avoid capture, as only this single larva has been captured after May 10.

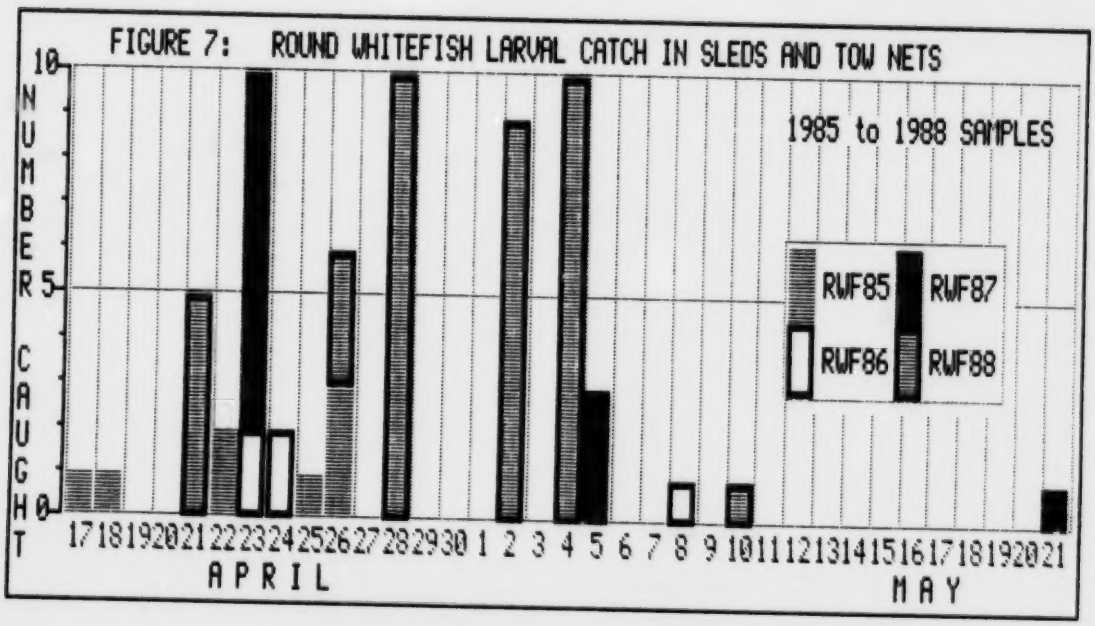


FIGURE 7: ROUND WHITEFISH LARVAL CATCH IN SLEDS AND TOW NETS
1985 to 1988 SAMPLES
NUMBER CAUGHT
10
5
0
RWF85
RWF87
RWF86
RWF88
17 18 19 20 21 22 23 24 25 26 27 28 29 30 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
APRIL
MAY

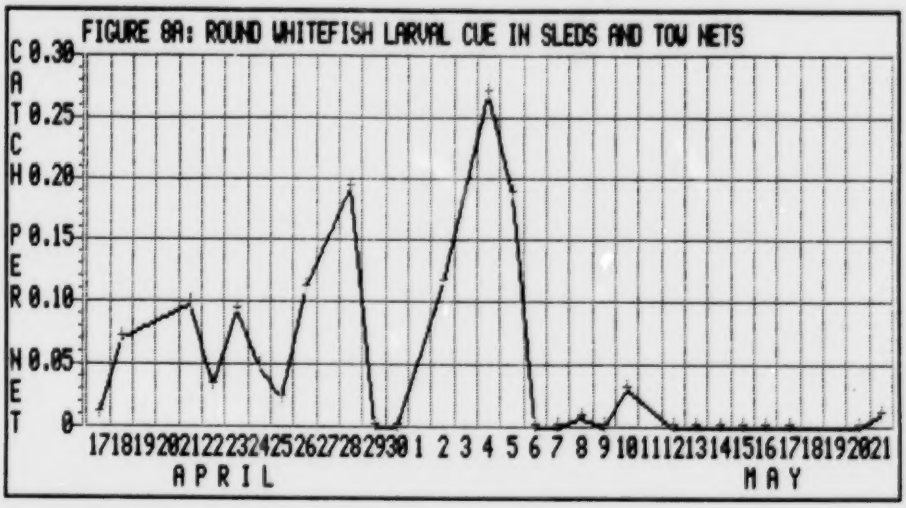


FIGURE 8A: ROUND WHITEFISH LARVAL CUE IN SLEDS AND TOW NETS
CATCH PER NET
0.30
0.25
0.20
0.15
0.10
0.05
0
17 18 19 20 21 22 23 24 25 26 27 28 29 30 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
APRIL
MAY

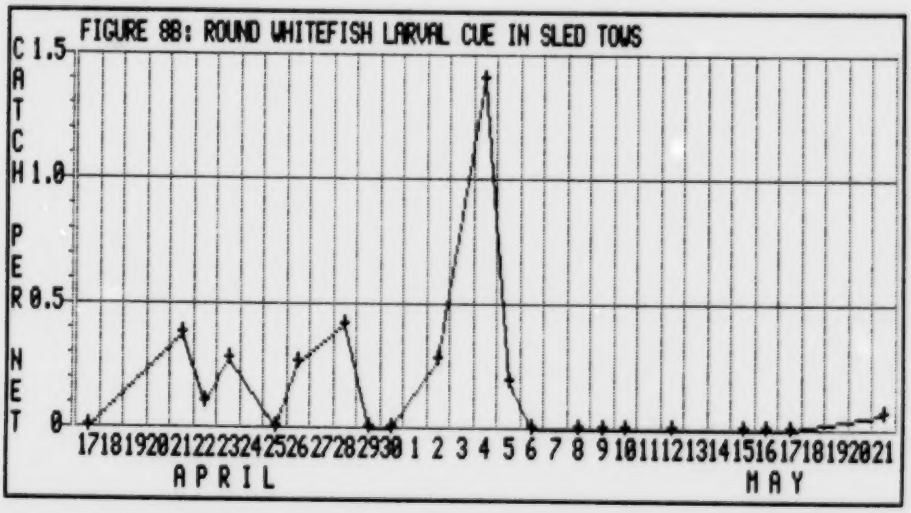


FIGURE 8B: ROUND WHITEFISH LARVAL CUE IN SLED TOWS
CATCH PER NET
1.5
1.0
0.5
0
17 18 19 20 21 22 23 24 25 26 27 28 29 30 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
APRIL
MAY

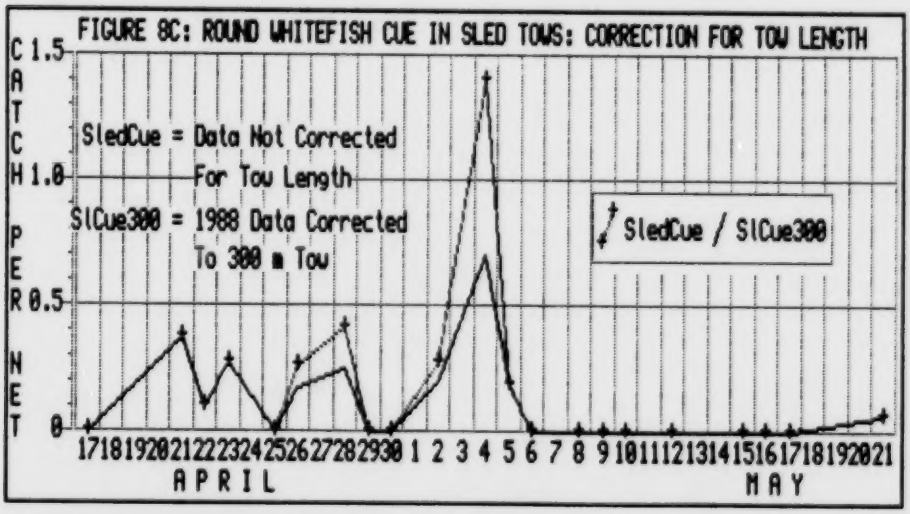


FIGURE 8C: ROUND WHITEFISH CUE IN SLED TOWS: CORRECTION FOR TOW LENGTH
CATCH PER NET
1.5
1.0
0.5
0
SledCue = Data Not Corrected For Tow Length
SlCue300 = 1988 Data Corrected To 300 m Tow
SledCue / SlCue300
17 18 19 20 21 22 23 24 25 26 27 28 29 30 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
APRIL
MAY

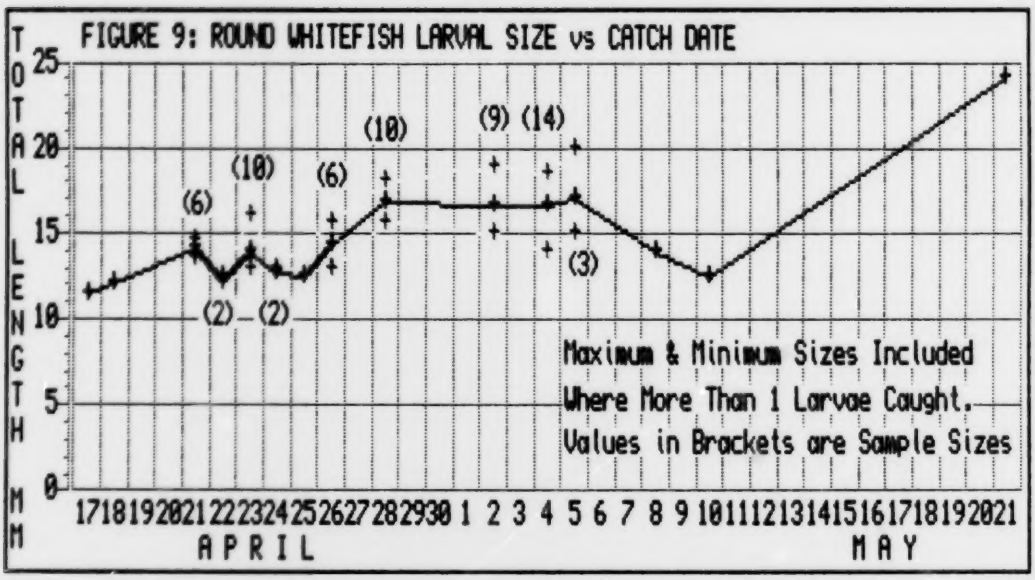


FIGURE 9: ROUND WHITEFISH LARVAL SIZE vs CATCH DATE
TOTAL LENGTH MM
25
20
15
10
5
0
(6)
(10)
(6)
(10)
(9)
(14)
(3)
(2)
(2)
Maximum & Minimum Sizes Included
Where More Than 1 Larvae Caught.
Values in Brackets are Sample Sizes
17 18 19 20 21 22 23 24 25 26 27 28 29 30 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
APRIL
MAY

The total round whitefish catch at various depths is plotted in Figure 10. Sampling effort at each depth has been reasonably consistent, with the exception of the 15 m contour, which was sampled only in 1985 and 1986. As indicated in Figure 10A, the majority of round whitefish larvae have been collected in bottom (sled) tows, with the highest catch at 5 meters. Sled catches declined with increasing depth. Only one larva was taken in sled tows beyond 10 m depth. Mid-depth tows yielded only 2 larvae, both at the 5 m contour. Surface catches occurred at the 10 m contour (4 larvae) and the 12 m contour (1 larva). Comparison of catches at the intake and diffuser locations (Figure 10B) indicates that highest catches at both sites occurred at 5 m, and diffuser catches greatly exceeded those at intake locations.

3.1.3 Sampling Recommendations

Sampling over the 1985-88 period indicates that round whitefish larvae can be collected in reasonable numbers if the sampling is conducted with the benthic sled, tows are done at night, and effort is concentrated in the late April to early May period.

Given the distribution of catch dates shown in Figures 7 and 8, it appears that the most intensive sampling should occur during the April 21 to May 5 period. Some additional sampling before and after this period, (probably at a reduced intensity) would also seem advisable in the event that hatch is unusually early or late on a given year. As Darlington becomes operational, more intensive early sampling may be required, especially if temperature monitoring indicates substantial amounts of bottom heating during the winter. Of particular interest is the period when only one or two units are operational, as reduced flow may limit the amount of initial mixing by the diffuser during this period, possibly reducing the effectiveness of the diffuser.

Data in Figure 10 clearly indicate that sampling should be concentrated in the 5 to 10 m depth range. While few larvae were collected at 12 m during the preoperational period, sampling at 12 m should be continued to determine if larvae are displaced offshore by the diffuser current. However, it should be noted that low larval densities may make such displacement very difficult to detect. Further sampling at 15 m does not appear to be worthwhile. It is suggested that sampling could be extended inshore to the 3 m contour to determine if the 5 m values actually represent peak abundance. This would likely be possible only at the diffuser location, due to shoreline filling associated with station construction inshore of the intake sampling sites. At the Thickson Point and Whitby sampling sites east of Pickering, sampling in 1984 and 1985 extended inshore to 3 m (OHRD Report 87-181-K). In that study, 6 larvae were collected at 7 m, 3 were taken at 5 m and 3 were taken at 3 m depth. None were collected at 9, 12 or 15 meters.

The very low catch obtained from surface and mid-depth samples indicates that tow-netting at these depths is not an effective method of sampling round whitefish larvae (Figure 10A). Future sampling should clearly be primarily based on benthic sled tows. When sled tows are being done, it is possible to also obtain a single tow net sample with little extra effort, but it is not possible to concurrently tow both surface and mid-depth nets as well as the benthic sled. Thus, sampling all three depths requires two separate tows over each sampling site. As there is a concern whether round whitefish may be displaced offshore by the diffuser current, it would appear that surface sampling would be most likely to collect displaced larvae. Also, while either surface or mid-depth samples can be collected concurrently with sled samples, it is more difficult to handle the mid-depth nets due to the net depressor and the need to closely maintain towing speed in order to sample the correct depth. For these reasons, it is suggested that mid-depth tows be eliminated from future sampling. The reduction in effort associated with elimination of the mid-depth tows should allow more frequent sampling (surface and bottom) at each site and may also allow an expansion in sampling effort to consider other sites.

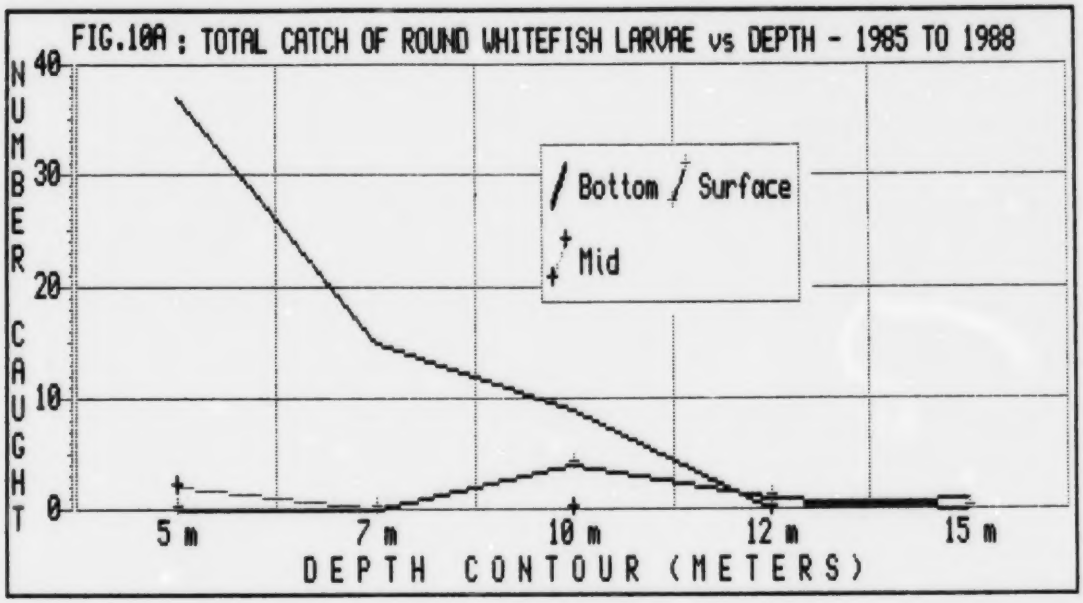


FIG.10A : TOTAL CATCH OF ROUND WHITEFISH LARVAE vs DEPTH - 1985 TO 1988
NUMBER CAUGHT
40
30
20
10
0
Bottom
Surface
Mid
5 m
7 m
10 m
12 m
15 m
DEPTH CONTOUR (METERS)

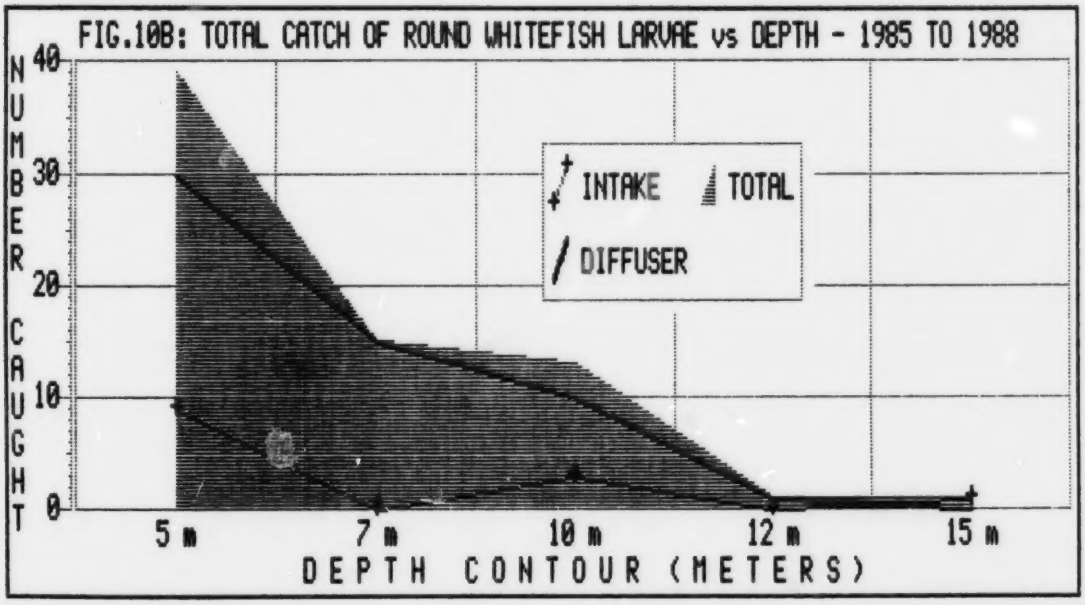


FIG.10B: TOTAL CATCH OF ROUND WHITEFISH LARVAE vs DEPTH - 1985 TO 1988
NUMBER CAUGHT
40
30
20
10
0
INTAKE
TOTAL
DIFFUSER
5 m
7 m
10 m
12 m
15 m
DEPTH CONTOUR (METERS)

Results in Figure 10B indicate that most round whitefish larvae have been taken from the diffuser sampling sites. During gillnet sampling in late November and December, the largest catches of ripe adults has generally occurred at the inshore end of the diffuser (OHRD Reports 87-82-K, 89-166-K; R.W. Sheehan, OHRD Report in preparation). However, as substantial round whitefish catches have also occurred at this time in gillnets at the west reference fishing area (3 km west of Darlington), it is suggested that larval fish should be sampled in this reference area. This would provide a reference site which should not be substantially altered by diffuser or intake currents. Due to the reduction in effort resulting from elimination of mid-depth tows, it should be possible to conduct frequent surface and bottom sampling (3 to 4 times per week) at the intake, diffuser, and west reference sites during the critical period. Although few larvae have been taken at the intake sites, elimination of this sampling area is not recommended, as sampling in this area will aid both the planning of entrainment sampling and interpretation of entrainment data.

3.1.4 Catches in Larval Drift Nets

During 1987, two pairs of drift nets were operated at the intake site, in depths of 5m and 7 m. The traps were deployed from April 23 to May 22 and were serviced by divers on 9 occasions. No round whitefish larvae were found in the 36 trap samples obtained (Appendix 5). As no round whitefish larvae were collected in tow net and sled samples taken from the intake area during 1987, it was not clear whether the lack of success with the trap was indicative of poor performance or simply an absence of larvae at this site. Therefore, the traps were tested again in 1988. Two pairs of traps were placed in 5 m and 7 m depth at the diffuser sites on April 29, 1988. The traps were serviced on three occasions from May 3 to May 17 (Appendix 6). A single round whitefish larva was collected from a trap at the 5 m depth on May 17. In addition, 3 sculpins were collected (one on May 17 and 2 on May 3). These results indicate that the larval drift nets are not suitable to sample round whitefish larvae in the open lake environment. However, they may be suitable for long term sampling in areas of higher flow, such as intake channels or forebays.

3.2 Entrainment Sampling

3.2.1 Rainbow Smelt

Preoperational entrainment sampling at the intake location was conducted twice per week (surface, mid-depth and bottom tows) during 1986 from April 17 to August 14. In April and May, samples were collected concurrently with sampling for round whitefish larvae (Appendix 2). From June to August, tow netting was conducted only at the intake location (Appendix 7). During the spring sampling in April and May (all sites considered) no larval smelt or alewife were captured. Rainbow smelt eggs were collected on May 6 (1 egg), May 8 (11 eggs) and May 15 (4 eggs). Smelt larvae were first collected on June 3 and peak catches (in surface, mid-depth and bottom nets) occurred on June 17 (Figure 11). Catches then declined, reaching zero on June 30 and July 1. A second, smaller peak in catch occurred over the July 7 to July 14 period. Only 3 smelt larvae were collected after July 21; one on August 5 and two on August 6. During the peak abundance periods in mid-June and early to mid-July, highest catches of smelt larvae were taken in surface nets and lowest catches were taken in bottom nets. However, it is not known if this pattern of depth distribution is altered during the daylight hours (all sampling was done at night).

Lengths of smelt larvae collected from June 3 to June 26 ranged from 5 to 6 mm, indicating that these were newly hatched larvae. Smelt captured on July 7 and July 9 ranged from 5 mm to 9 mm in length. Those collected on July 14 and 15 ranged from 6 to 18 mm long (Appendix 7). Thus, the July catches of smelt appear to be composed of some newly hatched larvae and some which had hatched earlier. Presumably, these larger larvae were survivors from the group sampled in

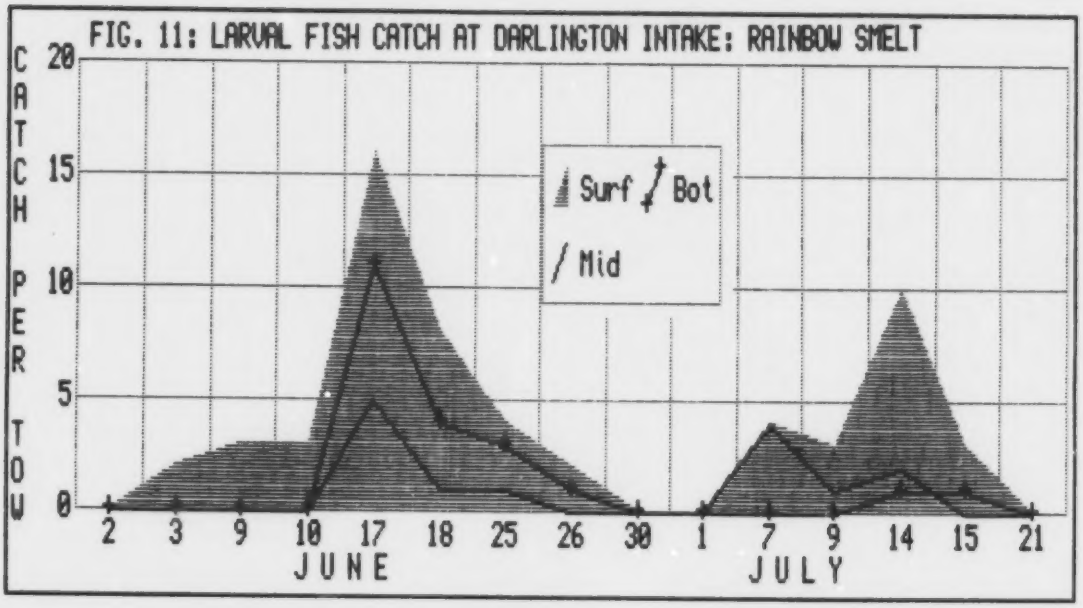


FIG. 11: LARVAL FISH CATCH AT DARLINGTON INTAKE: RAINBOW SMELT
CATCH PER TOW
20
15
10
5
0
Surf
Bot
Mid
2 3 9 10 17 18 25 26 30 1 7 9 14 15 21
JUNE
JULY

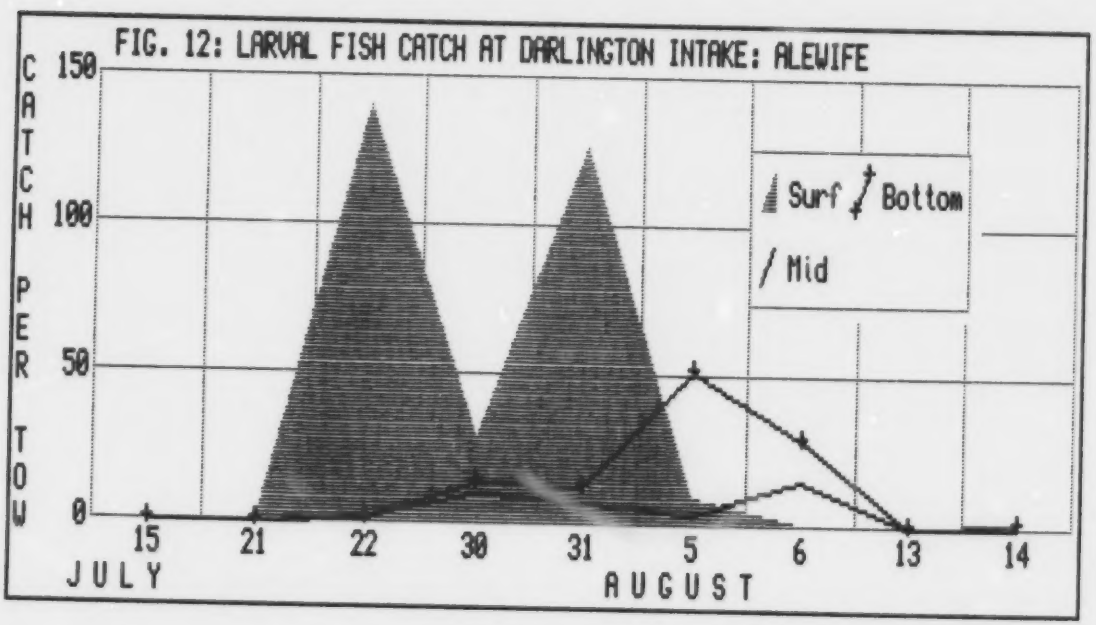


FIG. 12: LARVAL FISH CATCH AT DARLINGTON INTAKE: ALEWIFE
CATCH PER TOW
150
100
50
0
Surf
Bottom
Mid
15 21 22 30 31 5 6 13 14
JULY
AUGUST

mid-June. The larvae collected on August 5 and 6 were all large, ranging in length from 28 to 33 mm.

During 1986, smelt eggs were collected from May 6 to May 15. Incubation time vs temperature relationships of rainbow smelt eggs have been determined in the laboratory and vary from 7 days at 20°C to 35 days at 7°C (OHRD Report No 78-343-K). Simulation studies done in that report using "typical" spring temperatures for Darlington indicated that eggs spawned on May 16 would hatch on June 7. Thus it seems reasonable to conclude that smelt larvae collected in June were the progeny of spawnings that occurred in mid-May. However, it is unlikely that the small larvae collected over the July 7 to July 15 period were spawned in May. A second spawning, possibly in mid-June or later, is suggested by the presence of these larvae.

Although no smelt larvae were collected during May of 1986, smelt larvae were collected during round whitefish sampling conducted in other years. In 1985, a single smelt egg was collected on April 29 (Appendix 1). On May 8, one smelt larvae and 53 eggs were collected, and on May 16, 39 newly hatched smelt larvae (4-5 mm) were collected in surface and mid-depth tows. A further 7 larvae (6 mm length) and 5 smelt eggs were collected on May 23, 1985. No smelt eggs were collected in 1987, but the first larva was collected on May 13 (Appendix 3). On May 21, the last sampling day of 1987, 214 smelt larvae were collected in surface and mid-depth tows taken in the intake and diffuser areas. During 1988, the first smelt egg was collected on May 2 (Appendix 4). Sampling continued only to May 10 and on that day, 12 smelt larvae and one egg were collected.

These data indicate that in most years, smelt larvae will be present in the nearshore area during the second and third weeks of May, suggesting a spawning period in early April. A second spawning in early to mid-May results in hatch around mid-June, and the presence of small larvae in mid-July suggests a small spawning in mid to late June (at least in some years). While most smelt larvae have been collected in surface and mid-depth tows taken at night, it is not known if depth distributions are altered during daylight. However, it is clear that some smelt larvae will be entrained by the Darlington intake, and larvae could be expected in the CCW flow from early May to mid-July.

3.2.2 Alewife

During the 1986 entrainment sampling, alewife larvae were first collected in tow nets on July 22, with catches continuing to August 14 (Appendix 7). In the surface samples, which accounted for the bulk of the catch, peak catches occurred on July 22 and July 31 (Figure 12). Bottom catches peaked somewhat later than the surface catches (on August 5-6) and were only about 1/3 the size of the surface catches. Mid-depth catches were quite low throughout the sampling period. Peak catches of alewife larvae were about an order of magnitude greater than catches of smelt larvae in June and July of 1986.

Lengths of alewife larvae did not show a clear progression through the sampling period (Appendix 7). While some larger larvae (8.5 to 21 mm) were captured from July 30 to August 6, small, newly hatched larvae (3.5 mm to 5 mm) were collected throughout the sampling period. The presence of these small larvae suggests that alewife spawned over approximately a 3 week period during 1986. Alewife incubation periods vary from about 11 days at 10°C to about 4 days at 20°C (Edsall, 1970).

Examination of the catch data for the spring larval sampling over the 1985-88 period indicated that no larval alewife were collected during this sampling (Appendices 1 to 4). Some adult and juvenile alewife were collected in these tows, especially during May of 1986.

The preoperational entrainment sampling conducted in 1986 indicates that alewife larvae are likely to be entrained by the Darlington intake, especially over the late July to mid-August period. Numbers entrained are likely to be an order of magnitude higher than for rainbow smelt.

3.2.3 Other Species

During the spring sampling of 1985-88 and the entrainment sampling conducted in 1986, several other species of larval fish were collected in small numbers, and might be expected to be entrained in small numbers. On July 22, 1986, six newly hatched carp larvae (5-5.5 mm) were collected from a surface tow at the intake (Appendix 2). On May 8, 1985, a white sucker larva (13 mm long) was captured in diffuser surface tow at the 7 meter contour (Appendix 1). Five yellow perch larvae (5-6 mm) have been collected, all in mid-depth tows, at the 5, 7, 12 and 15 m contours. One was collected on May 21, 1986. Three were collected on April 23, 1987, and one was collected on May 4, 1987 (Appendix 3).

The presence of newly hatched perch larvae in late April was unexpected. Studies conducted in the vicinity of Lennox GS during 1975 indicated the presence of yellow perch larvae from the third week of May to the first week of June (OHRD Report No 76-335-K). It was expected that yellow perch spawning in the open waters of Lake Ontario would be somewhat later than at Lennox, situated at the outlet of the Bay of Quinte. Presumably, the perch larvae collected at Darlington originated from a nearby sheltered bay which warmed rapidly (McLaughlin Bay is a likely location). However, in order to produce larvae by April 23, spawning must have occurred almost a month earlier. Even assuming an average temperature of 10°C during incubation, perch embryos will require a period of 28 days to hatch (OHRD Report No 78-586-K).

In addition to the larval fish previously discussed, the spring larval sled tows have collected large numbers of juvenile and small adult sculpins. In 1985, only one sculpin egg was reported. In 1986, 23 sculpins were collected, and the catch jumped to 300 sculpins in 1987. The 1988 sampling, with greater emphasis on sled sampling and longer tows, yielded 1,456 sculpins (Appendix 4). While it is believed that sculpins should be resistant to entrainment through the intake structure, their abundance and presence on the intake structure (they have frequently been observed in video monitoring of the intake) will likely result in some entrainment or impingement when CCW flows increase.

3.3 Round Whitefish Egg Incubations

3.3.1 Field Observations

Round whitefish eggs were fertilized and placed in the incubators on December 16, 1986. The first two replicate chambers from each incubator were recovered on January 20, 1987. Subsequent recovery dates were February 16, March 24, April 7 and April 13, 1987. Basic data from the incubation experiment (development stages, survival) are listed in Appendix 8.

On the first recovery date (January 20) after 35 days of incubation, there were only minor differences in the development stage reached (Figure 13 A). Most eggs were at or slightly beyond development stage 9 (the formation of a free tail bud; OHRD Report No 80-140-K). Eggs from the offshore diffuser site (10 m) were almost a full stage ahead of those from the inshore (7 m) locations. By February 16 (day 62), this difference was quite pronounced, with the offshore diffuser eggs being about 1.5 stages ahead of the other groups (Figure 13 A). As spring approached, this difference was eroded until all groups were at the same stage of development (stage 19, just prior to hatch) by April 7. Hatch then occurred very quickly, as on April 13 (the last sample collection date) hatch was 77% complete, based on relative numbers of hatched larvae and unhatched, live eggs (Appendix 8).

FIGURE 13 A

ROUND WHITEFISH EGG DEVELOPMENT RATE

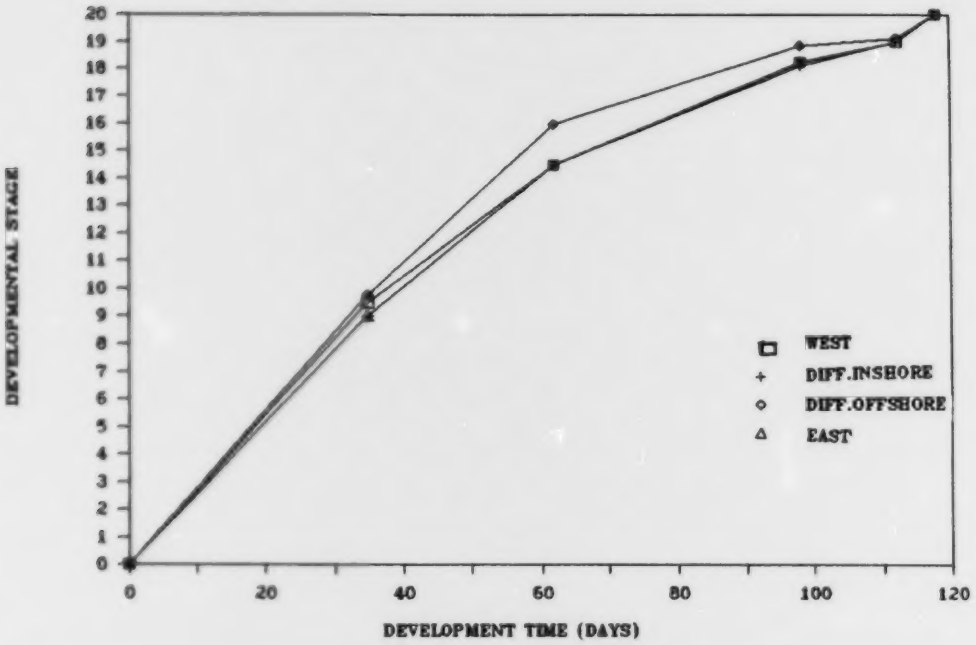
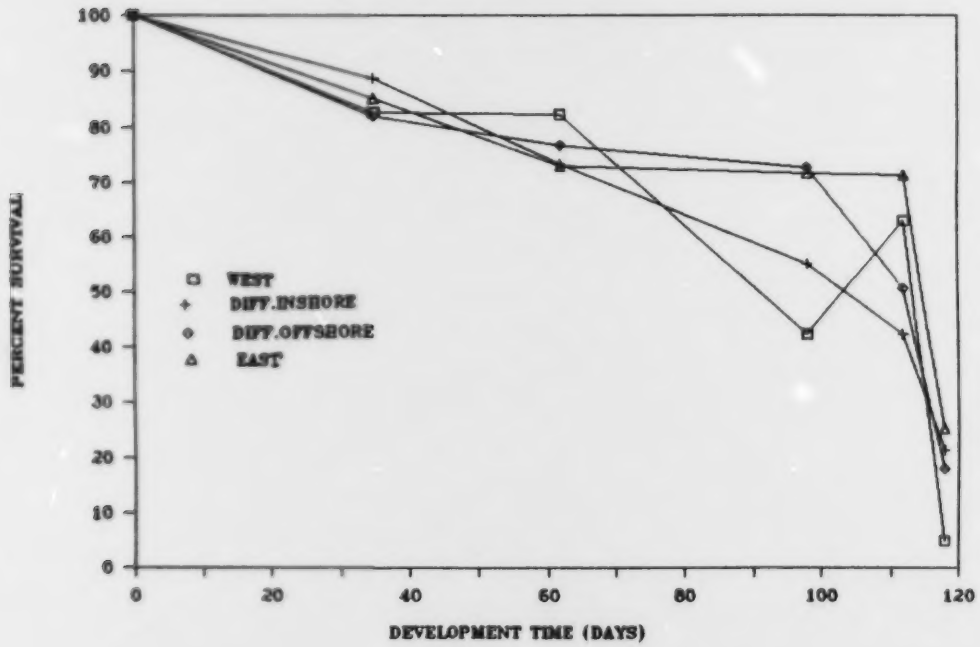


FIGURE 13 B

ROUND WHITEFISH EGGS: % SURVIVAL



Survival data for each incubator are plotted in Figure 13 B. Egg survival declined in a generally linear manner over the December 16 to April 7 period. Mean survivals (for all incubators) were 84.6% on January 20; 76.3% on February 16; 60.4% on March 24; and 56.8% on April 7. As incubation progressed, variation in survival estimates (between incubators, Figure 13B; and between replicate chambers, Appendix 8) increased substantially. The most variable results were shown by the west incubator. Over the hatching period, from April 7 to April 13, survival dropped dramatically (from an average of 56.8% to 17.4%). Mortalities included both dead eggs and substantial numbers of larvae which died after hatch (Appendix 8). Final survival (numbers of live larvae plus live eggs on April 13) ranged from 18.0% to 25.3% for the inshore diffuser, offshore diffuser and east sites (Figure 13B). Survival at the west site was only 5.0%.

3.3.2 Comparison With Pickering Studies

Darlington egg incubation results are compared with those obtained at Pickering over the winter of 1984-85 (OHRD Report No 87-181-K) in Figure 14. Egg development rates for the Darlington 7 m sites (west, inshore diffuser, east) were very similar. In Figure 14 A, development at the Darlington east site is compared with that obtained at Thickson Point (the Pickering control site).

For the first eight weeks of incubation, development occurred at an almost identical rate in the two studies. Eggs at Darlington developed more rapidly than those at Thickson Point after week 9, resulting in hatch about 1 week earlier (Figure 14 A). Temperatures shown in the figure are from thermographs operated by the Geotechnical and Hydraulic Engineering Department at Pickering in 1984-85 (OH D&D Report No 86093) and at Darlington in 1986-87 (OH D&D Report No 88283). Temperatures at Darlington were slightly lower (0.5 to 1°C) over the first 4 weeks of incubation. Temperatures were nearly identical at the two sites over weeks 5 to 14, then the Darlington temperatures rose more rapidly in the spring. It should be noted that temperatures and egg development in these two studies are plotted in relation to the egg fertilization date (December 11 in the Pickering study and December 16 at Darlington) rather than calendar dates. It should also be noted that in the Pickering study, thermographs were located very near bottom, only a few meters away from the egg incubators, while at Darlington, the thermograph was located at the 5 m depth and was a few hundred meters east and slightly inshore of the east incubator. Thus the temperature differences seen in the first few weeks of incubation may not be real, as temperatures at the Darlington thermograph site (TH16 - 5 m) may have cooled more rapidly than those at the east incubator.

In Figure 14 B, survival results are compared for Darlington (average of all sites) and several Pickering locations. The plot suggests that up to week 16, survival at Darlington generally exceeded that obtained at Thickson Point (Pickering control) and Simcoe Point (warmed by about 1°C). While the Pickering sites also displayed a drop in survival over the hatching period, it was less severe than at Darlington. Thus, the final survival at Darlington was comparable to that observed in the Pickering discharge area (PK 5 m site) where eggs were subjected to a 3° C temperature increase. The final Darlington survival was about half of that observed at Simcoe Point, Richardson Point and Thickson Point during the Pickering study.

3.3.3 Simulation Studies

Egg development and survival data obtained from the four Darlington incubation sites were compared with predicted values obtained from laboratory incubation models (OHRD Report No 80-140-K) and thermograph records. Temperature data were obtained from thermographs operated by the Geotechnical and Hydraulic Engineering Department over the December, 1986 to March, 1987 period (OH D&D Report No 88283). Additional data, covering the months of April and May were provided by D. Lawler of the Geotechnical and Hydraulic Engineering Dept.

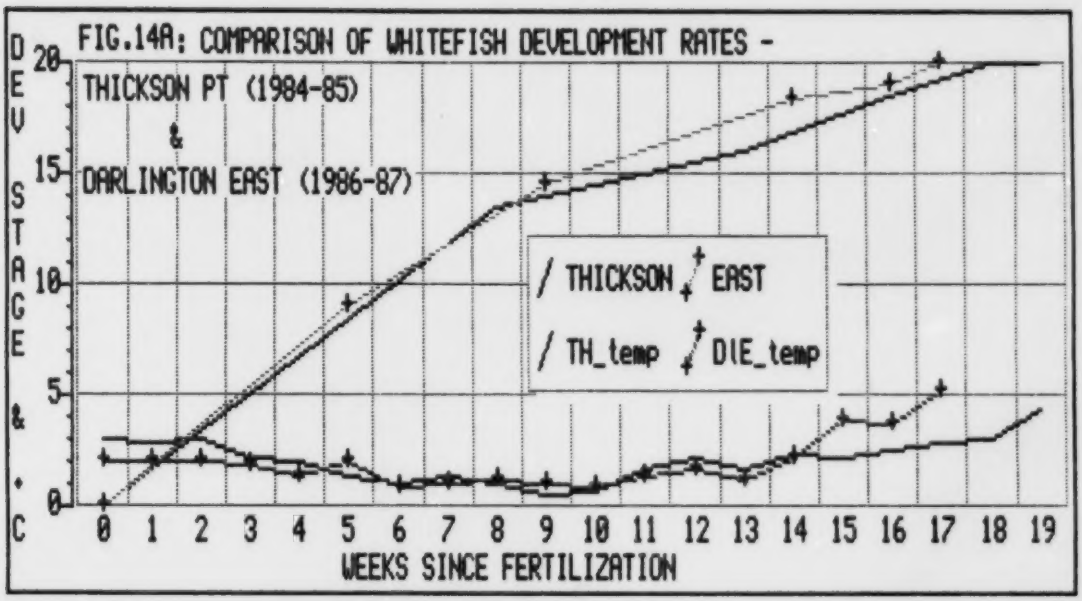


FIG.14A: COMPARISON OF WHITEFISH DEVELOPMENT RATES -
THICKSON PT (1984-85)
&
DARLINGTON EAST (1986-87)
/ THICKSON / EAST
/ TH_temp / DIE_temp
DEV STAGE & °C
0 5 10 15 20
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
WEEKS SINCE FERTILIZATION

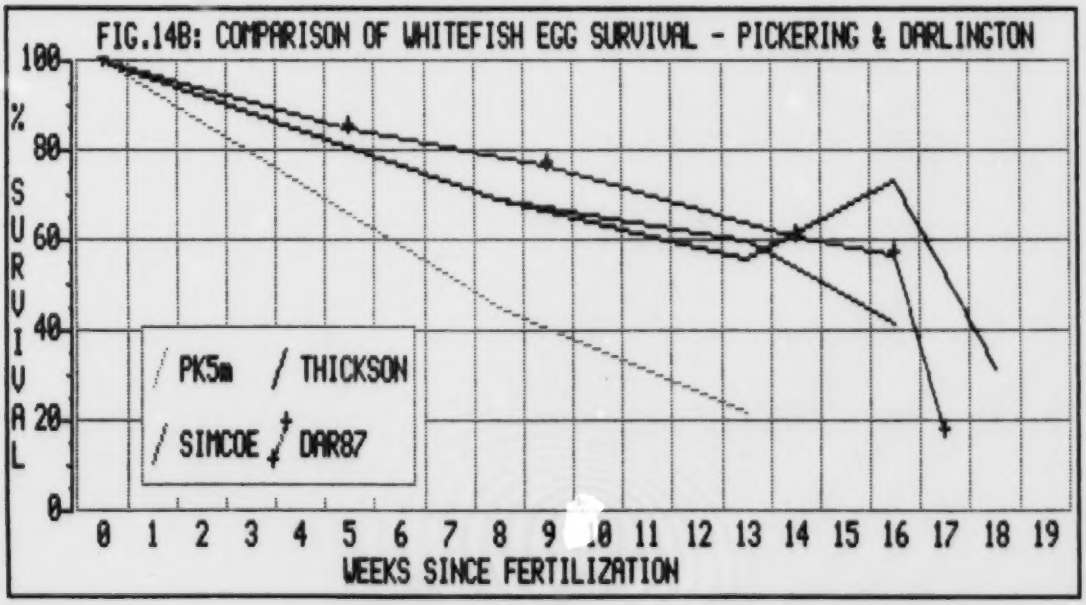


FIG.14B: COMPARISON OF WHITEFISH EGG SURVIVAL - PICKERING & DARLINGTON
% SURVIVAL
0 20 40 60 80 100
/ PK5m / THICKSON
/ SIMCOE / DAR87
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
WEEKS SINCE FERTILIZATION

The thermographs used were not deployed specifically for the egg incubation study, but as this was a preoperational study, with no thermal discharge present, it was felt that the available thermographs were sufficiently close to the incubators to provide reasonable temperature estimates.

The temperature record used to calculate expected development and survival at the east incubator was from thermograph TH-16 (Figure 6). This thermograph was located at 5 m depth, somewhat inshore and east of the incubator, and provided a continuous temperature record from egg fertilization (December 16) until the end of May. Temperatures at the west incubator were obtained from thermograph TH-13 (Figure 6). This thermograph, at 5 m depth, was west and inshore of the west egg incubator. As data were not available from thermograph TH-13 over the February 11 to March 26 period, the TH-16 data were used to cover this period during simulation calculations. Comparison of these two thermographs before and after the missing period indicated that temperatures were very similar at the two sites (monthly means for the two sites were within 0.1°C for December, January, April and May). Temperatures from thermograph TH-25 were used for the offshore diffuser incubator (Figure 6). This thermograph, at 8 m depth, was about 2 meters shallower than the incubator, and was less than 100 m from the incubation site. The TH-25 record was complete from December to May. There was no thermograph adjacent to the inshore diffuser incubator. The closest thermograph, TH-19, at the 5 m depth over the CCW intake, was used to estimate temperatures from December 16 to March 13, when the thermograph was removed. The inshore diffuser temperatures for the remainder of the period were estimated from TH-16 values.

The simulation procedure involved sequential computations with three sets of development and survival models (OHRD Report No 80-140-K). These included the period from fertilization to development stage 9 (Block 1 models), from stage 9 to stage 19 (Block 2 models) and from stage 19 to completion of hatch (Block 3 models). Daily mean temperatures were used for the simulation process. Beginning with the first day after fertilization, the Block 1 models were used to compute the percentage of Block 1 development completed and the daily mortality. Procedures were repeated and results accumulated until Block 1 was complete. The Block 2 models were then applied until stage 19 was reached, when the Block 3 models were finally used.

Development rates predicted from the temperature records are plotted in Figure 15A. Predicted development at the west and east incubators was almost identical throughout the entire incubation period. During the first 100 days of incubation, development at the inshore diffuser site was predicted to be slightly ahead of that at the east and west sites, while development at the offshore diffuser site was substantially ahead (1-2 stages) over this period. Faster development by eggs at the offshore diffuser site was evident from the field data (Figure 13A). Examination of the temperature records indicated that this deeper offshore site cooled more slowly, resulting in temperatures that were almost 1°C warmer than at the 7 m incubation sites during December and the first half of January. By mid February, temperatures were quite uniform at all incubation sites, and this condition continued until the third week of March. In-shore temperatures then exceeded the offshore values by about 0.5°C as spring warming progressed through late March and April. The spring warming regime thus resulted in a convergence of the development rate curves (both predicted, Figure 15A and observed, Figure 13A) after about 100 days of incubation.

In the field, hatch was nearly complete in all incubators on the final sampling day (April 13, day 118). The predicted dates of hatch completion were considerably later, ranging from day 140 to day 142. It has been suggested that factors in the field, especially wave induced agitation of eggs, may result in hatch occurring more rapidly than predicted by the laboratory models (OHRD Reports 80-140-K, 87-181-K). Reduced egg incubation time due to agitation has also been noted in European whitefish, *Coregonus lavaretus*, (Naesje and Jonsson, 1988).

FIGURE 15 A

PREDICTED DEVELOPMENT RATES

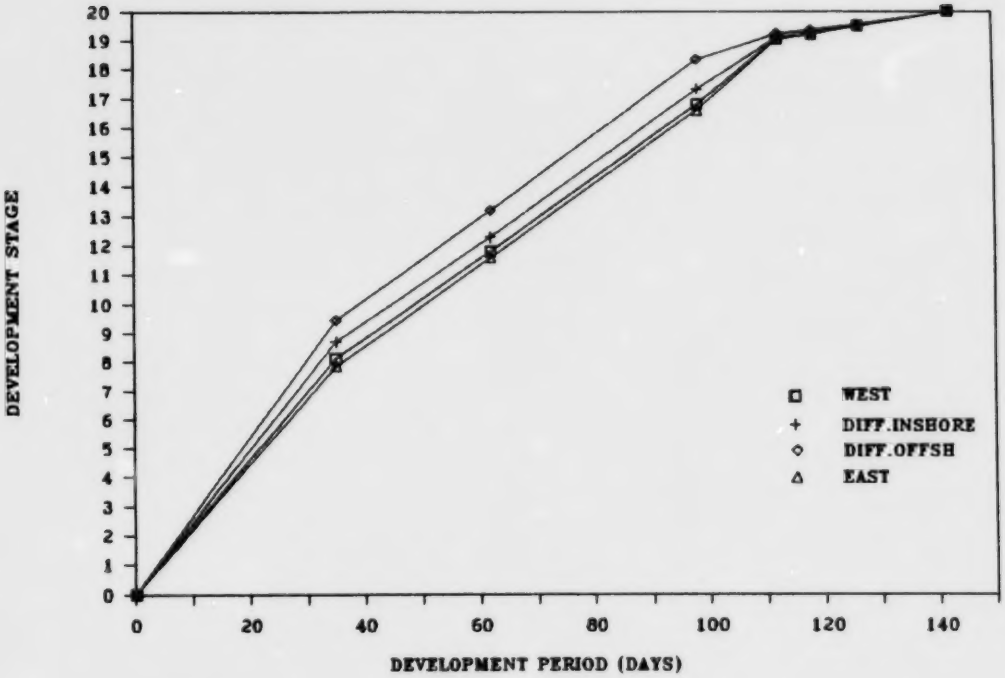
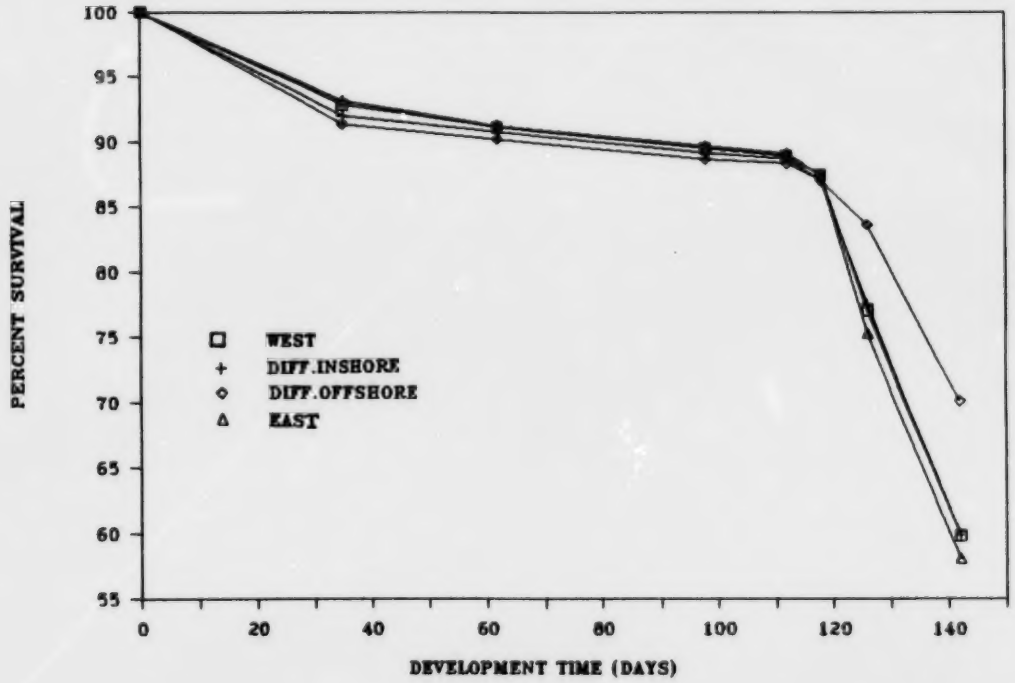


FIGURE 15 B

ROUND WHITEFISH EGGS: PREDICTED % SURV



In previous comparisons of field incubations and these round whitefish predictive models at Pickering, it was suggested that the predicted date for mean hatch (development stage 19.5) was a good estimator of field hatch dates (OHRD Report No 87-181-K). In the present study the predicted average date for mean hatch was April 20 (day 125), with a range from day 123 to day 127. Thus, hatch in the Darlington study (nearly complete by day 118) occurred at least one week earlier than expected (based on applications of these models at Pickering). In contrast, observed and predicted development on the previous sampling day (April 7, day 112) were almost identical, as both observations and predictions indicated that the eggs had just passed stage 19 (hatch just beginning). The observed average development on this day was stage 19.06, while the predicted value was stage 19.11.

Predicted survival curves for each incubator are shown in Figure 15B. The general form of the predicted survival curves is similar to the observed data (Figure 13B), as the models have predicted sharply increased mortality associated with the hatching period, but the survival values predicted by the models are much higher than observed results. The models predict a mean survival at the start of hatch (day 112) of 88.8%, and a final mean survival at hatch of 62%. Actual mean survivals were 56.8% on day 112 and 17.4% at hatch. Thus it is clear that predictions based on thermal models alone are inadequate to realistically predict survival in field incubators. Comparisons at Pickering also indicated that predicted survival substantially exceeded observed values, but in that study, where eggs were subjected to varying levels of temperature increase, these thermal models predicted the relative mortality increase associated with differing levels of temperature increase (OHRD Report No 87-181-K). In the present study, temperature differences between sites were minor, although slower spring warming at the offshore diffuser site resulted in less predicted mortality at that site during hatch (Figure 15B). However, observed results do not support this prediction (Figure 13B).

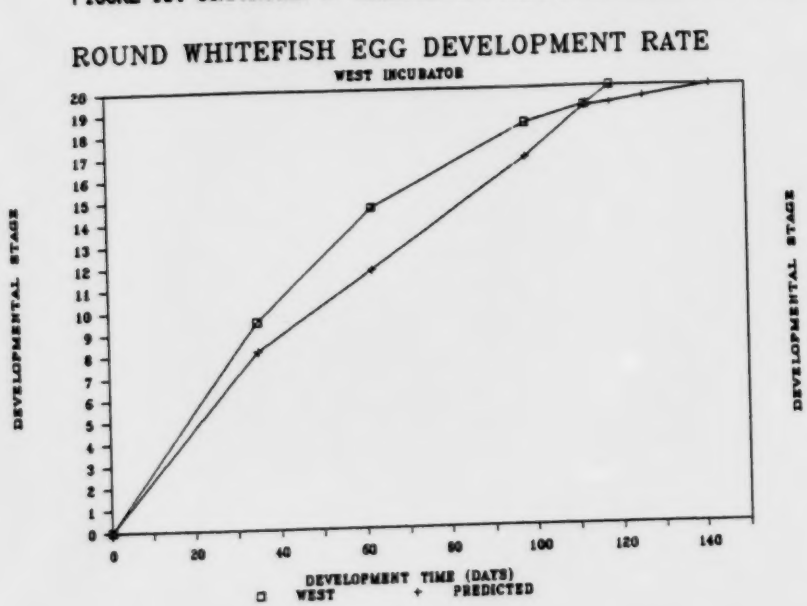
Observed and predicted development rates for individual incubators are compared in Figure 16. In all incubators, predicted development lagged behind observed development for the first 60 days of incubation, then predicted and observed rates converged, yielding almost identical values on day 112, at the beginning of hatch. As previously discussed, hatch in the field incubators then occurred much more quickly than predicted by the models.

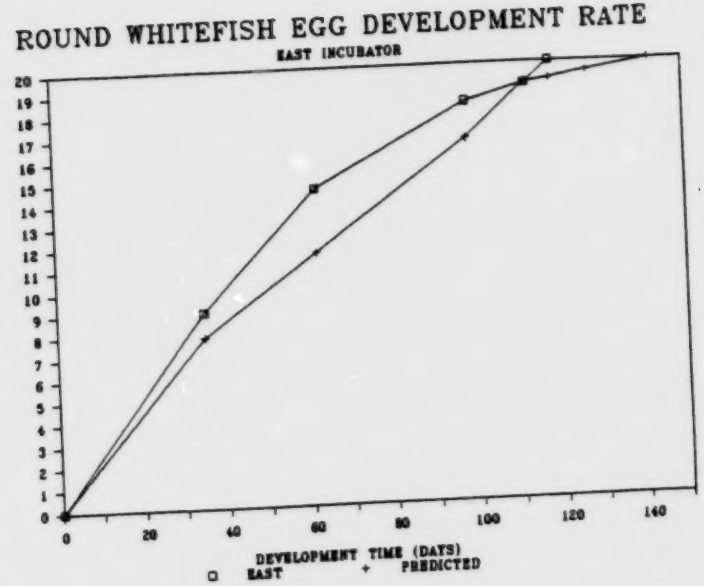
Percentage survival in each incubator is compared with predicted values in Figure 17. While the predicted survivals follow the same form as observed results, it is clear that the temperature models alone are not capable of realistically predicting observed survivals. In the observed survival plots, values for "total hatch" include both the observed live larvae plus dead larvae counted in the incubators (Appendix 8). The results indicate that substantial numbers of larvae died after hatch in all incubators. It is suggested that the accumulation of large amounts of sediment in the incubation chambers was responsible for the unexpectedly high mortality (of both eggs and larvae) associated with the hatching period. Attempts to quantify the sediment-mortality relationship will be described in the next section of this report.

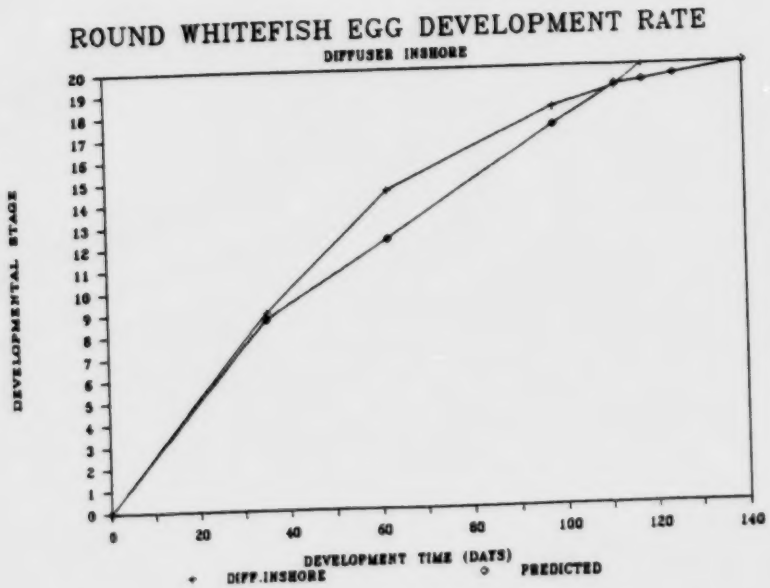
3.3.4 Sediments in the Incubators and Egg Mortality

Data on sediments accumulated in the egg incubators are listed in Appendix 9. Data for total accumulation (all material passing through a 1.0 mm screen) are plotted in Figure 18A. Values shown are for total accumulation in each pair of incubation chambers, including material collected from the transport buckets (see Methods section). On the first egg sampling day, after 35 days of incubation, only small amounts of sediment had accumulated in the chambers (less than 20 g/incubator). Up to day 98, total amounts of sediment in the diffuser offshore and east incubators increased gradually, but much higher amounts of sediment were present in the west and inshore diffuser incubators (Figure 18A). Total amounts of sediment increased sharply in all incubators during the last two sampling days (day 112 and day 118).

FIGURE 16: COMPARISON OF OBSERVED AND PREDICTED DEVELOPMENT RATES







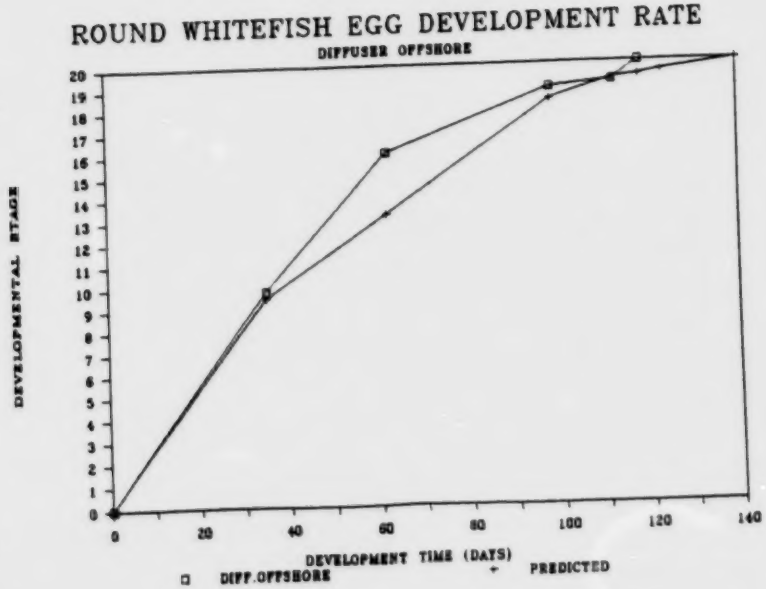


FIGURE 17: COMPARISON OF OBSERVED AND PREDICTED SURVIVAL

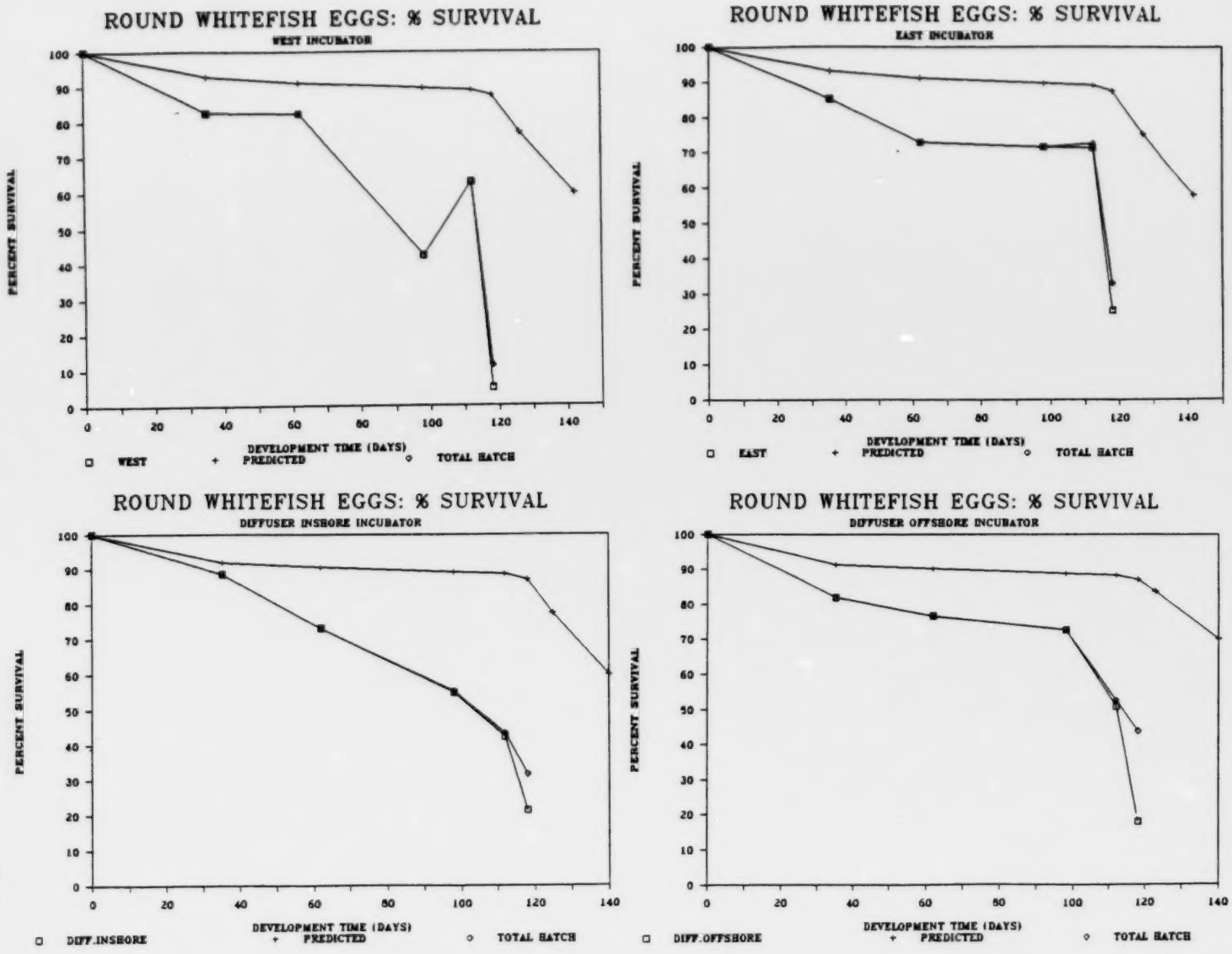


FIGURE 18 A

SEDIMENT VS INCUBATION TIME (DAYS)

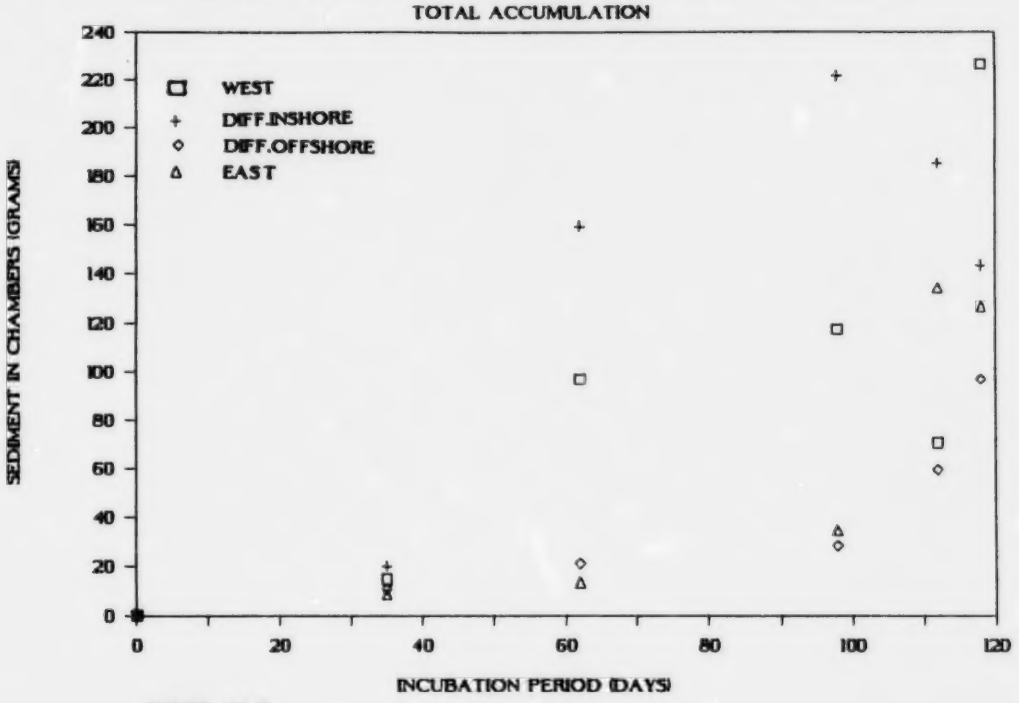
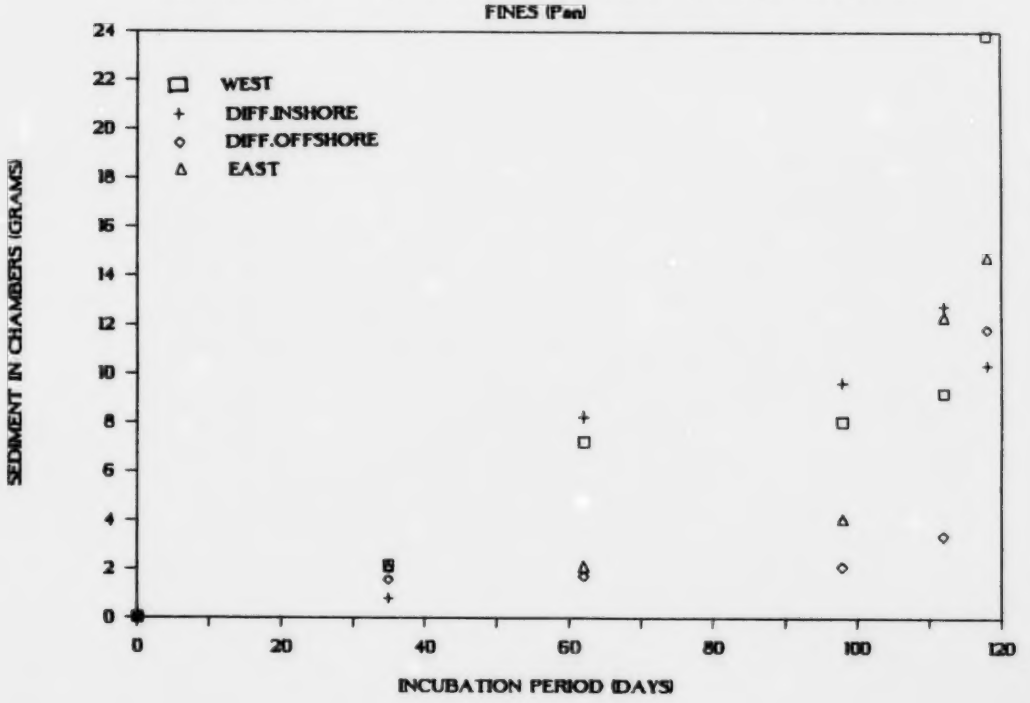


FIGURE 18 B

SEDIMENT VS INCUBATION TIME (DAYS)



In attempting to determine whether sediment accumulation in the incubators had an adverse effect on egg survival, the accumulation of fine materials is of interest, as fine particles are the most likely to inhibit oxygen exchange across the egg membrane. Accumulation of the "fines" (materials collected in the pan after passing through a 38 micron seive) is plotted in Figure 18B. The amount of accumulated fines increased gradually over the first 98 days of incubation, then increased very sharply over the last 20 days of the experiment. In general, the plot for accumulation of fine sediments (Figure 18B) is almost a mirror image of the survival plot.

As egg development proceeds, survival is expected to decline (based on laboratory-derived thermal models). However, as previously indicated, actual survival declined more rapidly than predicted. To obtain a measure of this additional mortality, the "excess mortality" (difference between observed and predicted mortality) was computed for each incubator on each sampling day (Appendix 10). This excess mortality was then regressed against various components (pan, pan+#400 seive, total sediment, etc.) of the accumulated sediments. The scatter plots and regression lines for total sediment and the "fines" (materials passing a 38 micron seive) are shown in Figure 19. While both regressions were significant, the better fit was provided by the "fines" regression (r^2 = 0.644, Appendix 10). Consideration of all the sediment components in a multiple regression (Appendix 10) only marginally improved the regression fit (r^2=0.677). Thus, it appeared that the amount of very fine materials accumulated in the incubation chambers provided the best correlation with the observed excess mortality.

The "excess mortality" regression was then combined with the thermal survival model to provide a new set of "predicted" survival curves. In constructing these curves, the expected survival was computed for each incubator and each sampling day from the thermal models. Then the "excess mortality" was computed from the individual fine sediment values, and this expected excess mortality was used to correct the survival values computed from the thermal models. In constructing this new "predicted" survival plot, it was also assumed that hatch would be complete by the predicted date for mean hatch, which effectively shortened the new predicted curve by about 1 week. Results for the two predictions (temperature only; temperature + sediment + mean hatch correction) are compared with observed survivals for each incubator in Figure 20. It is clear that survival values computed using the combination of the thermal models plus the sediment "correction" provide a good description of observed survival values, both throughout incubation and during the high mortality hatching period. Thus, the method developed should be useful in assessing both thermal effects from Darlington and any effects of the diffuser currents on sediment movement and deposition.

It should be noted that the "prediction" based on excess mortality computations is not a true prediction, as it has been computed from the same data set which it "predicts" in Figure 20. Thus, it is really a mathematical description of these results rather than a true prediction. In contrast, the thermal model prediction has been based on an independent data set (the laboratory egg incubations) and can be considered a true prediction. However, the combined thermal/sediment models may be used to predict results in future egg incubation experiments planned for Darlington (during two unit and four unit operation). Attempting to predict results of these future tests should be a good test of the validity of the procedures used here.

While the models used here may be useful to predict results of future similar experiments, they may also have a wider application. In the next egg incubation study, attempts will be made to correlate accumulation of sediments in the egg incubators with the flux of fine sediments in the water column (as measured by sediment collecting tubes). Then, the available sediment tube data (which includes 14 sites monitored since 1986) may be used to predict temporal (year to year) and spatial variations in hatch success. Temporal predictions will be compared with data on relative year-class strength (obtained from scale samples collected in our gill netting program).

FIGURE 19 A

EXCESS MORTALITY vs SEDIMENT

TOTAL SEDIMENT ACCUMULATION

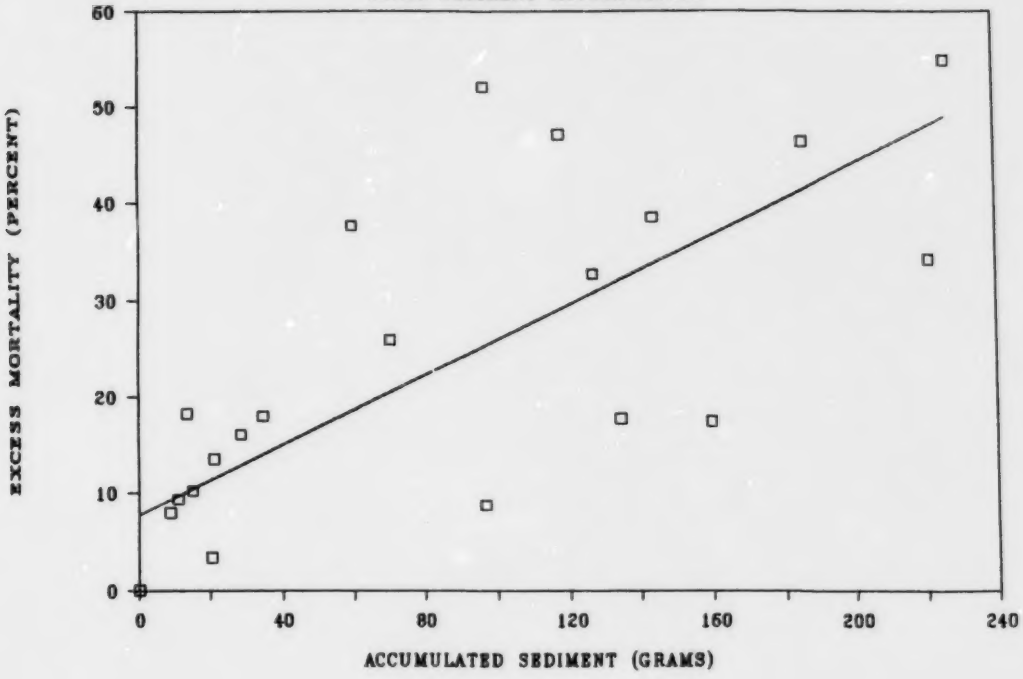


FIGURE 19 B

EXCESS MORTALITY vs SEDIMENT

FINES (PAN)

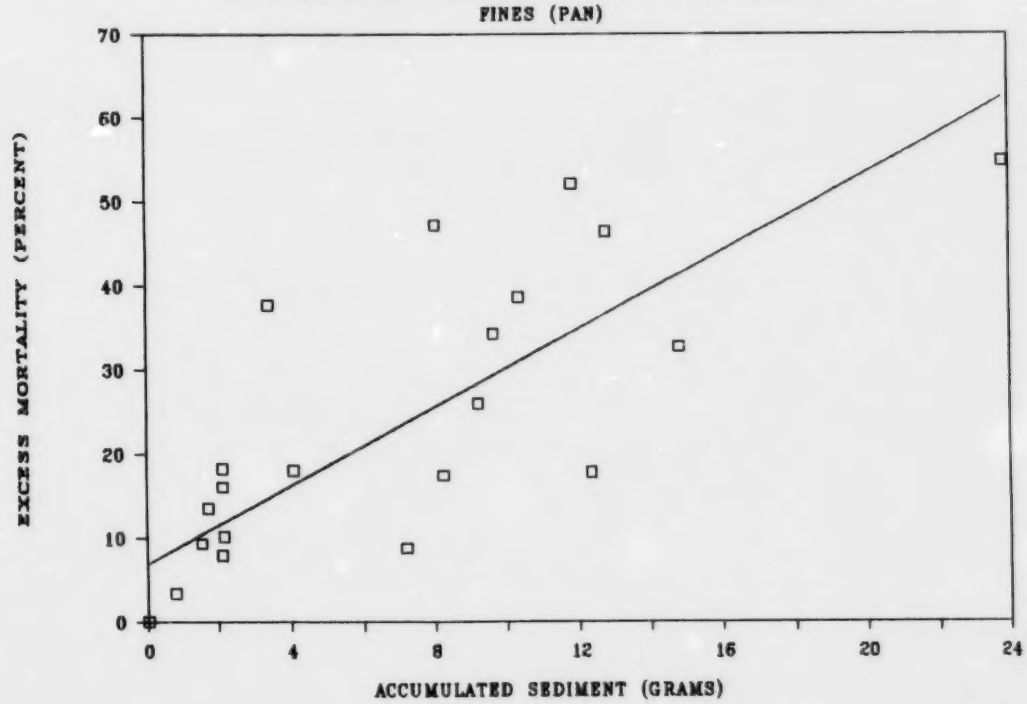
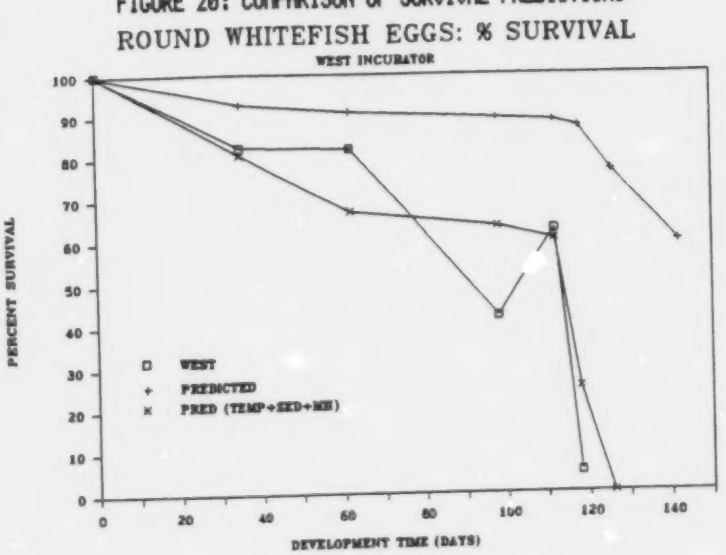
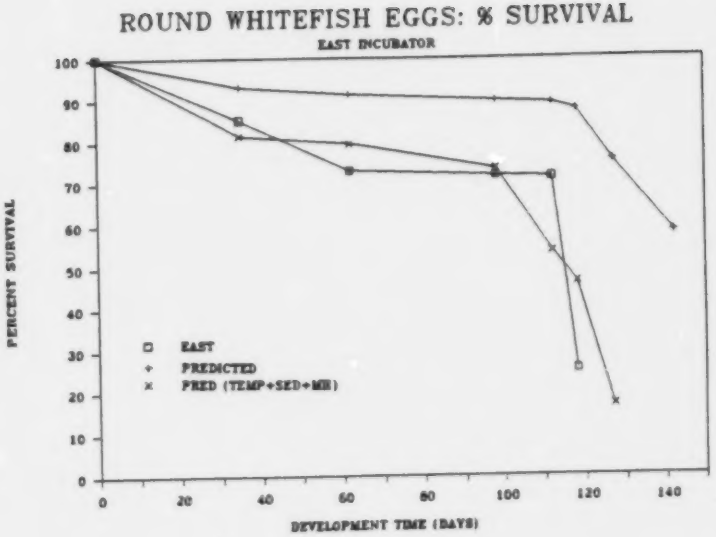
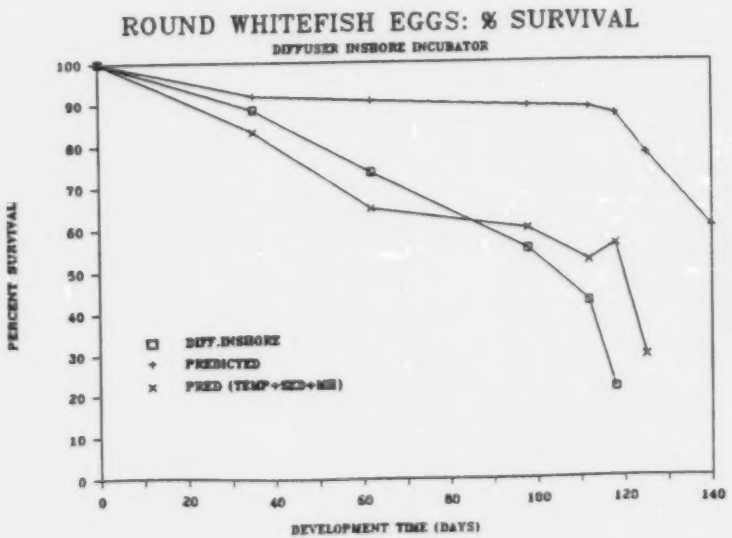
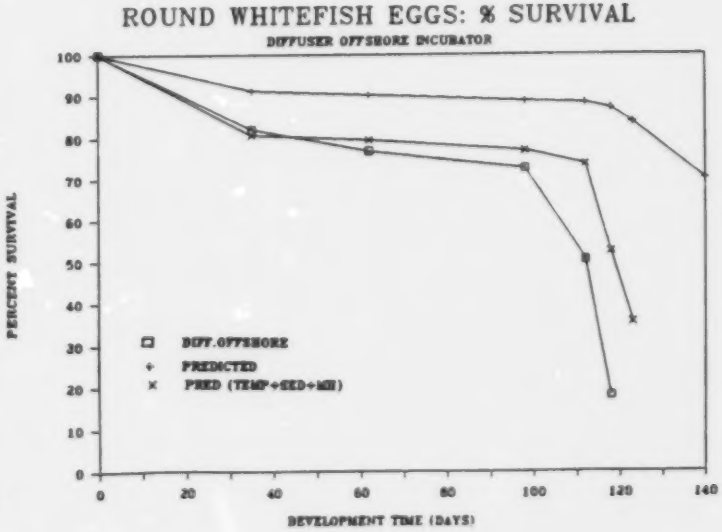


FIGURE 20: COMPARISON OF SURVIVAL PREDICTIONS









While present results suggest that egg survival in the incubators was strongly influenced by the amount of fine sediments accumulating in the egg chambers, it is not clear whether these incubators are representative of conditions in the natural substrate. At the start of incubation, the incubator substrates were very clean and probably contained less sediment than natural cobbles used for spawning. As the incubators sat on top of the substrate, they may have acted as sediment traps, accumulating sediment more rapidly than natural substrates. However, their exposed position may also have aided flushing by wave action. Thus, it not clear whether the incubators would yield higher or lower survival than natural cobble substrates.

While it would be desirable to obtain comparative survival data (from incubators and natural substrates) in the future, a rigorous comparison may prove very difficult to conduct, due to the adverse field conditions over the winter. Stormy weather severely limits the number of days on which sampling can be done. On several occasions during the present study (usually following a storm), divers recovered egg samples when the underwater visibility was absolutely zero. Fortunately, the design of the incubators allowed recovery of the egg baskets strictly by "feel". Quantitative sampling of natural substrates under such conditions may not be possible.

4.0 SUMMARY

1. From 1985 to 1988, sampling with paired 0.5 m tow nets (surface and mid-depth) and the benthic sled was conducted (from 5 to 15 m depth, in the vicinity of the intake and the discharge) for round whitefish larvae over the mid-April to late May period. In 1985, eight larvae were captured in 438 samples. In 1986, five larvae were collected from 484 samples. The 1987 catch was 12 larvae (from 348 samples), while in 1988, 174 samples yielded 43 larvae. The increased catch was attributed to increased emphasis on the benthic sled, concentration of effort during the late-April to early-May period, sampling at night with the benthic sled (started in 1987), and increasing tow length from 300 m to 600 m (begun in 1988).

2. Of the 68 round whitefish larvae captured, 61 were collected from bottom tows with the benthic sled, two were in mid-depth tows and 5 were in surface tows. Levels of effort were: benthic sled=426 samples; mid-depth=472 samples; surface=546 samples. Future sampling should concentrate on use of the sled, although surface tows (which can be done concurrently) should be continued to determine if larvae are being displaced offshore or upward by diffuser currents. It is recommended that mid-depth towing be discontinued.

3. Most larvae (38) were captured at the 5 m sampling depth. Catches were moderate at 7 m depth (15 fish) and 10 m depth (13 fish). Only a single larva was collected at each of the 12m and 15 m sampling depths. In future studies, it is suggested that some sampling be done inshore of 5 m to determine whether the 5 m catch represents the peak abundance. While continued sampling at 15 m is not recommended, the 12 m location in the discharge area should be sampled to determine whether offshore displacement of larvae is occurring.

4. The larval catch at the diffuser site (56 in 718 samples) was much greater than the intake catch (12 larvae in 726 samples), an observation in agreement with high adult catches near the inshore end of the diffuser during the spawning period. As high adult catches have also been observed at the west reference fishing site, it is suggested that future sampling should consider this location to provide a reference site for round whitefish larval sampling.

5. Larval drift nets were operated during 1987 at the intake location in depths of 5 m and 7 m from April 23 to May 22. No round whitefish larvae were collected. Operation of these traps at the diffuser locations (5 m and 7 m) during 1988 (April 29 to May 17) resulted in

the catch of only one round whitefish larva. Thus, it is concluded that these nets are not suitable for collection of larvae in the open lake environment. However, they may prove useful in areas of higher current (near the CCW intake, in the forebay or near the diffuser).

6. Entrainment preoperational sampling was conducted twice per week (surface, mid-depth and bottom tows) from April 17 to August 14, 1986. Rainbow smelt larvae were first collected on June 3, with peak abundance occurring on June 17. A second, smaller abundance peak was observed over the July 7 to July 14 period. Smelt larvae were most abundant in surface samples, but also occurred in mid-depth and bottom samples. Spring tow net and sled sampling done in other years indicated that smelt larvae are usually present during the second and third weeks of May. Thus, smelt larvae could be expected in the Darlington CCW flow from May to mid-July.

7. During 1986 entrainment sampling, alewife larvae were collected from July 22 to August 14. Peak catches in surface nets occurred on July 22 and August 31. Bottom catches peaked on August 5-6 and were only about 1/3 the size of surface catches. Alewife catches were about an order of magnitude larger than the catches of smelt larvae.

8. Several other species of larval fish were collected during spring tow netting and the 1986 entrainment sampling, and these may be occasionally entrained by the Darlington CCW intake. These include white sucker, carp and yellow perch. large catches of juvenile and adult sculpins in sled tows (mostly in 1987-88) suggest that some sculpins may also be entrained by the intake.

9. Round whitefish eggs were fertilized and placed in incubators at four sites on December 16, 1986. Eggs were sampled on five occasions until completion of hatch on April 13, 1987. As incubation progressed, egg survival gradually declined to an average value of 56.8% on April 7, when hatch was just beginning. Over the hatching period, survival decreased dramatically, to an average of 17.4% on April 13. Mortalities included both dead eggs and substantial numbers of larvae which died after hatch.

10. Expected egg development and survival were predicted from laboratory thermal models, using temperatures recorded by thermographs located near the egg incubators. Predicted development lagged behind observed development during the early portion of the incubation period. By the start of hatch (stage 19) on April 7, predicted development closely coincided with observed results. Hatch then occurred within one week, much faster than predicted. Previous studies at Pickering have suggested that the predicted date for 50% hatch (stage 19.5) closely coincided with observed hatch dates (within 2.3 days). At Darlington, hatch was nearly complete about 7 days before the predicted date for 50% hatch. Predicted survival followed a pattern similar to observed results (moderate early mortality, low mortality during the middle development period, and sharply increased mortality at hatch), but the predicted survivals were substantially higher than observed results.

11. Sediment accumulation in the incubation chambers increased steadily throughout the incubation period. The accumulation of fine materials (less than 38 microns) showed a very sharp rise over the last two weeks of incubation, and was almost a mirror image of the survival curves. The "excess mortality" values (difference between observed values and those predicted from the thermal models) were regressed against various size fractions of the sediments. The best correlation ($r^2 = 0.64$) was obtained for the finest sediments (those less than 38 microns diameter). A new set of survival curves was then "predicted" by a two-step process. At each sampling date, the survival value predicted from the thermal models was adjusted, using the "excess mortality" regression and the observed sedimentation

value. This corrected "prediction" closely corresponded with observed survival results.

12. The predictive value of the method developed in this study will be tested on a new egg incubation data set obtained when Darlington becomes operational. Additional data will also be obtained to correlate sediment accumulation within the incubators to sediment collection tube data. This should allow a realistic quantitative assessment of sedimentation effects on round whitefish egg survival, including local variations (possibly modified by station diffuser currents) and year-to-year variations (resulting from differences in weather).

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APPENDIX 1
DARLINGTON 1985 LARVAL FISH CATCH DATA

Surface & Mid-Depth samples collected with paired 0.5 m tow nets.
Bottom samples collected with benthic sled (paired 0.5 m nets)
All samples collected over 300 m distance, parallel to shore
approximately 5 minute tow at 1.0 m/s

DATE	LOCATION	DEPTH	RWF		SMELT	OTHERS
17-Apr-85	Int/Surf	5	0		0	0
17-Apr-85	Int/Surf	7	0		0	0
17-Apr-85	Int/Surf	10	0		0	0
17-Apr-85	Int/Surf	12	0		0	0
17-Apr-85	Int/Mid	5	0		0	0
17-Apr-85	Int/Mid	7	0		0	0
17-Apr-85	Int/Mid	10	0		0	0
17-Apr-85	Int/Mid	12	0		0	0
17-Apr-85	Disch/Surf	5	0		0	0
17-Apr-85	Disch/Surf	7	0		0	0
17-Apr-85	Disch/Surf	10	0		0	0
17-Apr-85	Disch/Surf	12	0		0	0
17-Apr-85	Disch/Surf	15	0		0	0
17-Apr-85	Disch/Mid	5	1	11.5 mm	0	0
17-Apr-85	Disch/Mid	7	0		0	0
17-Apr-85	Disch/Mid	10	0		0	0
17-Apr-85	Disch/Mid	12	0		0	0
17-Apr-85	Disch/Mid	15	0		0	0
18-Apr-85	Int/Surf	15	0		0	0
18-Apr-85	Int/Mid	15	0		0	0
18-Apr-85	Disch/Surf	5	0		0	0
18-Apr-85	Disch/Surf	7	0		0	0
18-Apr-85	Disch/Surf	10	0		0	0
18-Apr-85	Disch/Surf	12	1	12 mm	0	0
18-Apr-85	Disch/Surf	15	0		0	0
22-Apr-85	Int/Surf	5	0		0	0
22-Apr-85	Int/Surf	7	0		0	0
22-Apr-85	Int/Surf	10	0		0	0
22-Apr-85	Int/Surf	12	0		0	0
22-Apr-85	Int/Surf	15	0		0	0
22-Apr-85	Int/Mid	5	0		0	0
22-Apr-85	Int/Mid	7	0		0	0
22-Apr-85	Int/Mid	10	0		0	0
22-Apr-85	Int/Mid	12	0		0	0
22-Apr-85	Int/Mid	15	0		0	0

APPENDIX 1 CONTINUED
DARLINGTON 1985 LARVAL FISH CATCH DATA

DATE	LOCATION	DEPTH	RWF		SMELT		OTHERS
22-Apr-85	Int/Bot	5	0		0		0
22-Apr-85	Int/Bot	7	0		0		0
22-Apr-85	Int/Bot	10	1	12 mm	0		0
22-Apr-85	Int/Bot	12	0		0		0
22-Apr-85	Int/Bot	15	1	12.5 mm	0		0
22-Apr-85	Disch/Surf	5	0		0		0
22-Apr-85	Disch/Surf	7	0		0		0
22-Apr-85	Disch/Surf	10	0		0		0
22-Apr-85	Disch/Surf	12	0		0		0
22-Apr-85	Disch/Surf	15	0		0		0
22-Apr-85	Disch/Mid	5	0		1	72 mm	0
22-Apr-85	Disch/Mid	7	0		0	yearling	0
22-Apr-85	Disch/Mid	10	0		0		0
22-Apr-85	Disch/Mid	12	0		0		0
22-Apr-85	Disch/Mid	15	0		0		0
22-Apr-85	Disch/Bot	5	0		0		0
22-Apr-85	Disch/Bot	7	0		0		0
22-Apr-85	Disch/Bot	10	0		0		0
22-Apr-85	Disch/Bot	12	0		0		0
22-Apr-85	Disch/Bot	15	0		0		0
25-Apr-85	Int/Surf	5	0		0		0
25-Apr-85	Int/Surf	7	0		0		0
25-Apr-85	Int/Surf	10	1	12.5 mm	0		0
25-Apr-85	Int/Surf	12	0		0		0
25-Apr-85	Int/Surf	15	0		0		0
25-Apr-85	Int/Mid	5	0		0		0
25-Apr-85	Int/Mid	7	0		0		0
25-Apr-85	Int/Mid	10	0		0		0
25-Apr-85	Int/Mid	12	0		0		0
25-Apr-85	Int/Mid	15	0		0		0
25-Apr-85	Int/Bot	5	0		0		0
25-Apr-85	Int/Bot	7	0		0		0
25-Apr-85	Int/Bot	10	0		0		0
25-Apr-85	Int/Bot	12	0		0		0
25-Apr-85	Int/Bot	15	0		0		0
26-Apr-85	Disch/Surf	5	0		0		0
26-Apr-85	Disch/Surf	7	0		0		0
26-Apr-85	Disch/Surf	10	0		0		0
26-Apr-85	Disch/Surf	12	0		0		0
26-Apr-85	Disch/Surf	15	0		0		0

APPENDIX 1 CONTINUED
DARLINGTON 1985 LARVAL FISH CATCH DATA

DATE	LOCATION	DEPTH	RWP		SHELT		OTHERS
26-Apr-85	Disch/Mid	5	0		0		0
26-Apr-85	Disch/Mid	7	0		0		0
26-Apr-85	Disch/Mid	10	0		0		0
26-Apr-85	Disch/Mid	12	0		0		0
26-Apr-85	Disch/Mid	15	0		0		0
26-Apr-85	Disch/Bot	5	1	13 mm	0		0
26-Apr-85	Disch/Bot	7	2	13,15 mm	0		0
26-Apr-85	Disch/Bot	10	0		0		0
26-Apr-85	Disch/Bot	12	0		0		0
26-Apr-85	Disch/Bot	15	0		0		0
29-Apr-85	Int/Surf	5	0		0		0
29-Apr-85	Int/Surf	7	0		0		0
29-Apr-85	Int/Surf	10	0		0		0
29-Apr-85	Int/Surf	12	0		0		0
29-Apr-85	Int/Surf	15	0		0		0
29-Apr-85	Int/Mid	5	0		0		0
29-Apr-85	Int/Mid	7	0		0		0
29-Apr-85	Int/Mid	10	0		0		0
29-Apr-85	Int/Mid	12	0		0		0
29-Apr-85	Int/Mid	15	0		0		0
29-Apr-85	Int/Bot	5	0		0		0
29-Apr-85	Int/Bot	7	0		0		0
29-Apr-85	Int/Bot	10	0		0		0
29-Apr-85	Int/Bot	12	0		0		0
29-Apr-85	Int/Bot	15	0		0		0
29-Apr-85	Disch/Surf	5	0		0		0
29-Apr-85	Disch/Surf	7	0		0		0
29-Apr-85	Disch/Surf	10	0		0		0
29-Apr-85	Disch/Surf	12	0		0		0
29-Apr-85	Disch/Surf	15	0		0		0
29-Apr-85	Disch/Mid	5	0		0		0
29-Apr-85	Disch/Mid	7	0		0		0
29-Apr-85	Disch/Mid	10	0		0		0
29-Apr-85	Disch/Mid	12	0		0		0
29-Apr-85	Disch/Mid	15	0		0		0
29-Apr-85	Disch/Bot	5	0		0		0
29-Apr-85	Disch/Bot	7	0		1	(egg)	0
29-Apr-85	Disch/Bot	10	0		0		0
29-Apr-85	Disch/Bot	12	0		0		0
29-Apr-85	Disch/Bot	15	0		0		0

APPENDIX 1 CONTINUED
DARLINGTON 1985 LARVAL FISH CATCH DATA

DATE	LOCATION	DEPTH	RWF	SMELT		OTHERS
02-May-85	Int/Surf	5	0	0		0
02-May-85	Int/Surf	7	0	0		0
02-May-85	Int/Surf	10	0	0		0
02-May-85	Int/Surf	12	0	0		0
02-May-85	Int/Surf	15	0	0		0
02-May-85	Int/Mid	5	0	0		0
02-May-85	Int/Mid	7	0	0		0
02-May-85	Int/Mid	10	0	0		0
02-May-85	Int/Mid	12	0	0		0
02-May-85	Int/Mid	15	0	0		0
02-May-85	Int/Bot	5	0	0		0
02-May-85	Int/Bot	7	0	0		0
02-May-85	Int/Bot	10	0	0		0
02-May-85	Int/Bot	12	0	0		0
02-May-85	Int/Bot	15	0	0		0
02-May-85	Disch/Surf	5	0	0		0
02-May-85	Disch/Surf	7	0	0		0
02-May-85	Disch/Surf	10	0	0		0
02-May-85	Disch/Surf	12	0	0		0
02-May-85	Disch/Surf	15	0	0		0
02-May-85	Disch/Mid	5	0	0		0
02-May-85	Disch/Mid	7	0	0		0
02-May-85	Disch/Mid	10	0	0		0
02-May-85	Disch/Mid	12	0	0		0
02-May-85	Disch/Mid	15	0	0		0
02-May-85	Disch/Bot	5	0	0		0
02-May-85	Disch/Bot	7	0	0		0
02-May-85	Disch/Bot	10	0	0		0
02-May-85	Disch/Bot	12	0	0		0
02-May-85	Disch/Bot	15	0	0		0
08-May-85	Int/Surf	5	0	0		0
08-May-85	Int/Surf	7	0	0		0
08-May-85	Int/Surf	10	0	0		0
08-May-85	Int/Surf	12	0	0		0
08-May-85	Int/Surf	15	0	0		0
08-May-85	Int/Mid	5	0	0		0
08-May-85	Int/Mid	7	0	1	(egg)	0
08-May-85	Int/Mid	10	0	0		0
08-May-85	Int/Mid	12	0	0		0
08-May-85	Int/Mid	15	0	0		0

APPENDIX 1 CONTINUED
DARLINGTON 1985 LARVAL FISH CATCH DATA

DATE	LOCATION	DEPTH	RWF	SMELT		OTHERS
08-May-85	Int/Bot	5	0	1	(egg)	0
08-May-85	Int/Bot	7	0	36	(eggs)	1 (sculpin egg)
08-May-85	Int/Bot	10	0	0		0
08-May-85	Int/Bot	12	0	0		0
08-May-85	Int/Bot	15	0	1	(egg)	0
08-May-85	Disch/Bot	5	0	0		0
08-May-85	Disch/Bot	7	0	0		0
08-May-85	Disch/Bot	10	0	6	(eggs)	0
08-May-85	Disch/Bot	12	0	1	(egg)	0
08-May-85	Disch/Bot	15	0	0		0
08-May-85	Disch/Surf	5	0	1	6 mm	0
08-May-85	Disch/Surf	7	0	0		1 wht sucker 13mm
08-May-85	Disch/Surf	10	0	0		0
08-May-85	Disch/Surf	12	0	1	(egg)	0
08-May-85	Disch/Surf	15	0	0		0
08-May-85	Disch/Mid	5	0	2	(eggs)	0
08-May-85	Disch/Mid	7	0	2	(eggs)	0
08-May-85	Disch/Mid	10	0	0		0
08-May-85	Disch/Mid	12	0	1	(egg)	0
08-May-85	Disch/Mid	15	0	0		0
08-May-85	Disch/Bot	5	0	0		0
08-May-85	Disch/Bot	7	0	0		0
08-May-85	Disch/Bot	10	0	0		0
08-May-85	Disch/Bot	12	0	1	(egg)	0
08-May-85	Disch/Bot	15	0	0		0
09-May-85	Int/Bot	5	0	0		0
09-May-85	Int/Bot	7	0	0		0
09-May-85	Int/Bot	10	0	0		0
09-May-85	Int/Bot	12	0	0		0
09-May-85	Int/Bot	15	0	0		0
16-May-85	Disch/Surf	5	0	10	avg 5 mm	0
16-May-85	Disch/Surf	7	0	4	4-6 mm	0
16-May-85	Disch/Surf	10	0	0		0
16-May-85	Disch/Surf	12	0	0		0
16-May-85	Disch/Surf	15	0	0		0
16-May-85	Disch/Mid	5	0	7	5-6 mm	0
16-May-85	Disch/Mid	7	0	1	6 mm	0
16-May-85	Disch/Mid	10	0	0		0
16-May-85	Disch/Mid	12	0	0		0
16-May-85	Disch/Mid	15	0	0		0
16-May-85	Disch/Bot		samples		lost	

APPENDIX 1 CONTINUED
DARLINGTON 1985 LARVAL FISH CATCH DATA

DATE	LOCATION	DEPTH	RWF	SMELT	OTHERS
16-May-85	Int/Surf	5	0	8 avg 5.5mm	0
16-May-85	Int/Surf	7	0	3 avg 5.2mm	0
16-May-85	Int/Surf	10	0	0	0
16-May-85	Int/Surf	12	0	0	0
16-May-85	Int/Surf	15	0	0	0
16-May-85	Int/Mid	5	0	5 avg 4.8mm	0
16-May-85	Int/Mid	7	0	1 5.5 mm	0
16-May-85	Int/Mid	10	0	0	0
16-May-85	Int/Mid	12	0	0	0
16-May-85	Int/Mid	15	0	0	0
16-May-85	Int/Bot	5	0	0	0
16-May-85	Int/Bot	7	0	0	0
16-May-85	Int/Bot	10	0	0	0
16-May-85	Int/Bot	12	0	0	0
16-May-85	Int/Bot	15	0	0	0
17-May-85	Disch/Bot	5	0	0	0
17-May-85	Disch/Bot	7	0	0	0
17-May-85	Disch/Bot	10	0	0	0
17-May-85	Disch/Bot	12	0	0	0
17-May-85	Disch/Bot	15	0	0	0
23-May-85	Int/Surf	5	0	1 6 mm	0
23-May-85	Int/Surf	7	0	0	0
23-May-85	Int/Surf	10	0	0	0
23-May-85	Int/Mid	10	0	6 6 mm (+5 eggs)	0

APPENDIX 2
DARLINGTON 1986 SPRING LARVAL FISH CATCH

EACH TOW LISTED CONSISTS OF PAIRED NETS (2 SAMPLES)

DATE	SITE	LOCATION	RWF		SMELT	OTHERS
17-Apr-86	Intake	5m/Bot	0		0	0
17-Apr-86	Intake	7m/Bot	0		0	0
17-Apr-86	Intake	10m/Bot	0		0	0
17-Apr-86	Intake	12m/Bot	0		0	0
17-Apr-86	Intake	15m/Bot	0		0	1 unident egg
17-Apr-86	Disch	5m/Bot	0		0	0
17-Apr-86	Disch	7m/Bot	0		0	1 slimy sculpin
17-Apr-86	Disch	10m/Bot	0		0	1 slimy sculpin
17-Apr-86	Disch	12m/Bot	0		0	1 slimy sculpin
17-Apr-86	Disch	15m/Bot	0		0	0
17-Apr-86	Intake	5m/Surf	0		0	0
17-Apr-86	Intake	5m/Mid	0		0	0
17-Apr-86	Intake	7m/Surf	0		0	0
17-Apr-86	Intake	7m/Mid	0		0	0
17-Apr-86	Intake	10m/Surf	0		0	1 burbot egg
17-Apr-86	Intake	10m/Mid	0		0	0
17-Apr-86	Intake	10m/Bot*	0		0	0
17-Apr-86	Intake	12m/Surf	0		0	0
17-Apr-86	Intake	12m/Mid	0		0	0
17-Apr-86	Intake	15m/Surf	0		0	0
17-Apr-86	Intake	15m/Mid	0		0	0
17-Apr-86	Disch	5m/Surf	0		0	0
17-Apr-86	Disch	5m/Mid	0		0	0
17-Apr-86	Disch	7m/Surf	0		0	0
17-Apr-86	Disch	7m/Mid	0		0	0
17-Apr-86	Disch	10m/Surf	0		0	0
17-Apr-86	Disch	10m/Mid	0		0	0
17-Apr-86	Disch	12m/Surf	0		0	0
17-Apr-86	Disch	12m/Mid	0		0	0
17-Apr-86	Disch	15m/Surf	0		0	0
17-Apr-86	Disch	15m/Mid	0		0	0
23-Apr-86	Intake	5m/Bot	0		0	0
23-Apr-86	Intake	7m/Bot	0		0	0
23-Apr-86	Intake	10m/Bot	0		0	1 Alewife Juvenile
23-Apr-86	Intake	12m/Bot	0		0	0
23-Apr-86	Intake	15m/Bot	0		0	0
23-Apr-86	Disch	5m/Bot	1	13.0 mm	0	0
23-Apr-86	Disch	7m/Bot	0		0	0
23-Apr-86	Disch	10m/Bot	1	13.0 mm	0	0
23-Apr-86	Disch	12m/Bot	0		0	0
23-Apr-86	Disch	15m/Bot	0		0	0

APPENDIX 2 CONTINUED
DARLINGTON 1986 SPRING LARVAL FISH CATCH

DATE	SITE	LOCATION	RWF	SHELT	OTHERS
23-Apr-86	Intake	5m/Surf	0	0	0
23-Apr-86	Intake	5m/Mid	0	0	0
23-Apr-86	Intake	7m/Surf	0	0	0
23-Apr-86	Intake	7m/Mid	0	0	0
23-Apr-86	Intake	10m/Surf	0	0	0
23-Apr-86	Intake	10m/Mid	0	0	0
23-Apr-86	Intake	10m/Bot*	0	0	0
23-Apr-86	Intake	12m/Surf	0	0	0
23-Apr-86	Intake	12m/Mid	0	0	0
23-Apr-86	Intake	15m/Surf	0	0	0
23-Apr-86	Intake	15m/Mid	0	0	0
23-Apr-86	Disch	5m/Surf	0	0	0
23-Apr-86	Disch	5m/Mid	0	0	0
23-Apr-86	Disch	7m/Surf	0	0	0
23-Apr-86	Disch	7m/Mid	0	0	0
23-Apr-86	Disch	10m/Surf	0	0	0
23-Apr-86	Disch	10m/Mid	0	0	0
23-Apr-86	Disch	12m/Surf	0	0	0
23-Apr-86	Disch	12m/Mid	0	0	0
23-Apr-86	Disch	15m/Surf	0	0	0
23-Apr-86	Disch	15m/Mid	0	0	0
24-Apr-86	Intake	5m/Surf	0	0	0
24-Apr-86	Intake	5m/Mid	0	0	0
24-Apr-86	Intake	7m/Surf	0	0	0
24-Apr-86	Intake	7m/Mid	0	0	0
24-Apr-86	Intake	10m/Surf	0	0	0
24-Apr-86	Intake	10m/Mid	0	0	0
24-Apr-86	Intake	10m/Bot*	0	0	0
24-Apr-86	Intake	12m/Surf	0	0	0
24-Apr-86	Intake	12m/Mid	0	0	0
24-Apr-86	Intake	15m/Surf	0	0	0
24-Apr-86	Intake	15m/Mid	0	0	0
24-Apr-86	Disch	5m/Surf	0	0	0
24-Apr-86	Disch	5m/Mid	0	0	0
24-Apr-86	Disch	7m/Surf	0	0	0
24-Apr-86	Disch	7m/Mid	0	0	0
24-Apr-86	Disch	10m/Surf	2 13, 12.5mm	0	0
24-Apr-86	Disch	10m/Mid	0	0	0
24-Apr-86	Disch	12m/Surf	0	0	0
24-Apr-86	Disch	12m/Mid	0	0	0
24-Apr-86	Disch	15m/Surf	0	0	0
24-Apr-86	Disch	15m/Mid	0	0	0

APPENDIX 2 CONTINUED
DARLINGTON 1986 SPRING LARVAL FISH CATCH

DATE	SITE	LOCATION	RNF	SMELT	OTHERS
30-Apr-86	Intake	5m/Surf	0	0	0
30-Apr-86	Intake	5m/Mid	no sample	no sample	no sample
30-Apr-86	Intake	7m/Surf	0	0	3 slimy sculpin
30-Apr-86	Intake	7m/Mid	no sample	no sample	no sample
30-Apr-86	Intake	10m/Surf	0	0	0
30-Apr-86	Intake	10m/Mid	no sample	no sample	no sample
30-Apr-86	Intake	10m/Bot*	no sample	no sample	no sample
30-Apr-86	Intake	12m/Surf	0	0	1 slimy sculpin
30-Apr-86	Intake	12m/Mid	no sample	no sample	no sample
30-Apr-86	Intake	15m/Surf	0	0	0
30-Apr-86	Intake	15m/Mid	0	0	0
30-Apr-86	Disch	5m/Surf	0	0	0
30-Apr-86	Disch	7m/Surf	0	0	0
30-Apr-86	Disch	10m/Surf	0	0	0
30-Apr-86	Disch	12m/Surf	0	0	2 slimy sculpin, egg
30-Apr-86	Disch	15m/Surf	0	0	1 slimy sculpin
06-May-86	Int	5m/Bot	0	0	2 slimy sculpin
06-May-86	Int	7m/SBot	0	0	0
06-May-86	Int	10m/Bot	0	0	0
06-May-86	Int	12m/Bot	0	0	0
06-May-86	Int	15m/Bot	0	0	0
06-May-86	Disch	5m/Bot	0	0	0
06-May-86	Disch	7m/SBot	0	0	0
06-May-86	Disch	10m/Bot	0	0	1 slimy sculpin
06-May-86	Disch	12m/Bot	0	0	0
06-May-86	Disch	15m/Bot	0	1 egg	0
07-May-86	Intake	5m/Surf	0	0	0
07-May-86	Intake	5m/Mid	0	0	0
07-May-86	Intake	7m/Surf	0	0	0
07-May-86	Intake	7m/Mid	0	0	0
07-May-86	Intake	10m/Surf	0	0	0
07-May-86	Intake	10m/Mid	0	0	0
07-May-86	Intake	10m/Bot*	0	0	0
07-May-86	Intake	12m/Surf	0	0	0
07-May-86	Intake	12m/Mid	0	0	0
07-May-86	Intake	15m/Surf	0	0	0
07-May-86	Intake	15m/Mid	0	0	0

APPENDIX 2 CONTINUED

DARLINGTON 1986 SPRING LARVAL FISH CATCH

DATE	SITE	LOCATION	RWF		SMELT	OTHERS
07-May-86	Disch	5m/Surf	0		0	0
07-May-86	Disch	5m/Mid	0		0	0
07-May-86	Disch	7m/Surf	0		0	0
07-May-86	Disch	7m/Mid	0		0	0
07-May-86	Disch	10m/Surf	0		0	0
07-May-86	Disch	10m/Mid	0		0	0
07-May-86	Disch	12m/Surf	0		0	0
07-May-86	Disch	12m/Mid	0		0	0
07-May-86	Disch	15m/Surf	0		0	0
07-May-86	Disch	15m/Mid	0		0	0
08-May-86	Intake	5m/Surf	0		0	0
08-May-86	Intake	5m/Mid	1	14 mm	0	0
08-May-86	Intake	7m/Surf	0		0	0
08-May-86	Intake	7m/Mid	0		1 egg	0
08-May-86	Intake	10m/Surf	0		0	0
08-May-86	Intake	10m/Mid	0		0	0
08-May-86	Intake	10m/Bot*	0		0	0
08-May-86	Intake	12m/Surf	0		0	0
08-May-86	Intake	12m/Mid	0		0	0
08-May-86	Intake	15m/Surf	0		0	0
08-May-86	Intake	15m/Mid	0		0	0
08-May-86	Disch	5m/Surf	0		2 eggs	0
08-May-86	Disch	5m/Mid	0		1 egg	0
08-May-86	Disch	7m/Surf	0		4 eggs	0
08-May-86	Disch	7m/Mid	0		0	0
08-May-86	Disch	10m/Surf	0		3 eggs	0
08-May-86	Disch	10m/Mid	0		0	0
08-May-86	Disch	12m/Surf	0		0	0
08-May-86	Disch	12m/Mid	0		0	0
08-May-86	Disch	15m/Surf	0		0	0
08-May-86	Disch	15m/Mid	0		0	0
15-May-86	Int	5m/Bot	0		0	0
15-May-86	Int	7m/SBot	0		0	2 slimy sculpins
15-May-86	Int	10m/Bot	0		0	0
15-May-86	Int	12m/Bot	0		0	0
15-May-86	Int	15m/Bot	0		3 eggs	1 slimy sculpin
15-May-86	Disch	5m/Bot?	0		0	2 slimy sculpins
15-May-86	Disch	7m/SBot	0		0	1 slimy sculpin
15-May-86	Disch	10m/Bot	0		0	1 johnny darter
15-May-86	Disch	12m/Bot	0		0	1 slimy sculpin
15-May-86	Disch	15m/Bot	0		1 egg	0

APPENDII 2 CONTINUED
DARLINGTON 1986 SPRING LARVAL FISH CATCH

DATE	SITE	LOCATION	RWF	SHELT	OTHERS
20-May-86	Intake	5m/Surf	0	0	0
20-May-86	Intake	5m/Mid	0	0	0
20-May-86	Intake	7m/Surf	0	0	0
20-May-86	Intake	7m/Mid	0	0	1 alewife juv.
20-May-86	Intake	10m/Surf	0	0	1 alewife juv.
20-May-86	Intake	10m/Mid	0	0	1 alewife juv.
20-May-86	Intake	10m/Bot*	0	0	0
20-May-86	Intake	12m/Surf	0	0	0
20-May-86	Intake	12m/Mid	0	0	0
20-May-86	Intake	15m/Surf	0	0	0
20-May-86	Intake	15m/Mid	0	0	0
20-May-86	Disch	5m/Surf	0	0	0
20-May-86	Disch	5m/Mid	0	0	0
20-May-86	Disch	7m/Surf	0	0	0
20-May-86	Disch	7m/Mid	0	0	0
20-May-86	Disch	10m/Surf	0	0	0
20-May-86	Disch	10m/Mid	0	0	0
20-May-86	Disch	12m/Surf	0	1 juv. 110 m	0
20-May-86	Disch	12m/Mid	0	0	0
20-May-86	Disch	15m/Surf	0	0	0
20-May-86	Disch	15m/Mid	0	0	0
21-May-86	Intake	5m/Surf	0	0	1 alewife adult
21-May-86	Intake	5m/Mid	0	0	0
21-May-86	Intake	7m/Surf	0	0	0
21-May-86	Intake	7m/Mid	0	0	0
21-May-86	Intake	10m/Surf	0	0	0
21-May-86	Intake	10m/Mid	0	0	0
21-May-86	Intake	10m/Bot*	0	0	0
21-May-86	Intake	12m/Surf	0	0	0
21-May-86	Intake	12m/Mid	0	0	0
21-May-86	Intake	15m/Surf	0	0	0
21-May-86	Intake	15m/Mid	0	0	1 Y perch 6mm
21-May-86	Disch	5m/Surf	0	0	0
21-May-86	Disch	5m/Mid	0	0	0
21-May-86	Disch	7m/Surf	0	0	0
21-May-86	Disch	7m/Mid	0	0	0
21-May-86	Disch	10m/Surf	0	0	0
21-May-86	Disch	10m/Mid	0	0	0
21-May-86	Disch	12m/Surf	0	0	0
21-May-86	Disch	12m/Mid	0	0	0
21-May-86	Disch	15m/Surf	0	0	0
21-May-86	Disch	15m/Mid	0	0	0
22-May-86	Int	5m/Bot	0	0	0
22-May-86	Int	7m/SBot	0	0	0
22-May-86	Int	10m/Bot	0	0	0
22-May-86	Int	12m/Bot	0	0	1 slimy sculpin
22-May-86	Int	15m/Bot	0	0	0

APPENDIX 2 CONTINUED
DARLINGTON 1986 SPRING LARVAL FISH CATCH

DATE	SITE	LOCATION	BWF	SHELT	OTHERS
22-May-86	Disch	5m/Bot	0	0	0
22-May-86	Disch	7m/SBot	0	0	0
22-May-86	Disch	10m/Bot	0	0	0
22-May-86	Disch	12m/Bot	0	0	0
22-May-86	Disch	15m/Bot	0	0	1 slimy sculpin
26-May-86	Intake	5m/Surf	0	0	0
26-May-86	Intake	5m/Mid	0	0	0
26-May-86	Intake	7m/Surf	0	0	0
26-May-86	Intake	7m/Mid	0	0	0
26-May-86	Intake	10m/Surf	0	0	0
26-May-86	Intake	10m/Mid	0	0	0
26-May-86	Intake	10m/Bot*	0	0	1 alewife juv.
26-May-86	Intake	12m/Surf	0	0	1 alewife adult
26-May-86	Intake	12m/Mid	0	0	0
26-May-86	Intake	15m/Surf	0	0	0
26-May-86	Intake	15m/Mid	0	0	0
26-May-86	Disch	5m/Surf	0	0	1 alewife juv.
26-May-86	Disch	5m/Mid	0	0	0
26-May-86	Disch	7m/Surf	0	0	2 alewife adult
26-May-86	Disch	7m/Mid	0	0	0
26-May-86	Disch	10m/Surf	0	0	0
26-May-86	Disch	10m/Mid	0	0	0
26-May-86	Disch	12m/Surf	0	0	0
26-May-86	Disch	12m/Mid	0	0	0
26-May-86	Disch	15m/Surf	0	0	0
26-May-86	Disch	15m/Mid	0	0	0
27-May-86	Intake	5m/Surf	0	0	2 alewife adults
27-May-86	Intake	5m/Mid	0	0	0
27-May-86	Intake	7m/Surf	0	0	0
27-May-86	Intake	7m/Mid	0	0	0
27-May-86	Intake	10m/Surf	0	0	0
27-May-86	Intake	10m/Mid	0	0	0
27-May-86	Intake	10m/Bot*	0	0	0
27-May-86	Intake	12m/Surf	0	0	1 alewife adult
27-May-86	Intake	12m/Mid	0	0	0
27-May-86	Intake	15m/Surf	0	0	0
27-May-86	Intake	15m/Mid	0	0	0
27-May-86	Disch	5m/Surf	0	0	3 alewife adults
27-May-86	Disch	5m/Mid	0	0	1 alewife adult
27-May-86	Disch	7m/Surf	0	0	0
27-May-86	Disch	7m/Mid	0	0	1 alewife adult
27-May-86	Disch	10m/Surf	0	0	0
27-May-86	Disch	10m/Mid	0	0	0
27-May-86	Disch	12m/Surf	0	0	1 alewife adult
27-May-86	Disch	12m/Mid	0	0	0
27-May-86	Disch	15m/Surf	0	0	0
27-May-86	Disch	15m/Mid	0	0	0

APPENDIX 3
DARLINGTON 1987 LARVAL FISH CATCH DATA

DATE	LOCATION	DEPTH	NET	BWF	SHELT	OTHERS
21-Apr-87	Intake	5m/Surf	A	0	0	0
21-Apr-87	Intake	5m/Surf	B	0	0	0
21-Apr-87	Intake	5m/Surf	Combined	0	0	0
21-Apr-87	Intake	5m/Mid	A	0	0	0
21-Apr-87	Intake	5m/Mid	B	0	0	0
21-Apr-87	Intake	5m/Mid	Combined	0	0	0
21-Apr-87	Intake	5m/Bot	A			
21-Apr-87	Intake	5m/Bot	B			
21-Apr-87	Intake	5m/Bot	Combined	0	0	0
21-Apr-87	Intake	7m/Surf	A	0	0	0
21-Apr-87	Intake	7m/Surf	B	0	0	0
21-Apr-87	Intake	7m/Surf	Combined	0	0	0
21-Apr-87	Intake	7m/Mid	A			
21-Apr-87	Intake	7m/Mid	B			
21-Apr-87	Intake	7m/Mid	Combined	0	0	0
21-Apr-87	Intake	7m/Bot	A			
21-Apr-87	Intake	7m/Bot	B			
21-Apr-87	Intake	7m/Bot	Combined	0	0	0
21-Apr-87	Intake	10m/Surf	A	0	0	0
21-Apr-87	Intake	10m/Surf	B	0	0	0
21-Apr-87	Intake	10m/Surf	Combined	0	0	0
21-Apr-87	Intake	10m/Mid	A	0	0	0
21-Apr-87	Intake	10m/Mid	B	0	0	0
21-Apr-87	Intake	10m/Mid	Combined	0	0	0
21-Apr-87	Intake	10m/Bot	A			
21-Apr-87	Intake	10m/Bot	B			
21-Apr-87	Intake	10m/Bot	Combined	0	0	0
21-Apr-87	Intake	12m/Surf	A	0	0	0
21-Apr-87	Intake	12m/Surf	B	0	0	0
21-Apr-87	Intake	12m/Surf	Combined	0	0	0
21-Apr-87	Intake	12m/Mid	A	0	0	0
21-Apr-87	Intake	12m/Mid	B	0	0	0
21-Apr-87	Intake	12m/Mid	Combined	0	0	0
21-Apr-87	Intake	12m/Bot	A			
21-Apr-87	Intake	12m/Bot	B			
21-Apr-87	Intake	12m/Bot	Combined	0	0	0

APPENDIX 3 CONTINUED
DARLINGTON 1987 LARVAL FISH CATCH DATA

DATE	LOCATION	DEPTH	NET	RWF	SHELT	OTHERS
21-Apr-87	Disch	5m/Surf	A	0	0	0
21-Apr-87	Disch	5m/Surf	B	0	0	0
21-Apr-87	Disch	5m/Surf	Combined	0	0	0
21-Apr-87	Disch	5m/Mid	A	0	0	0
21-Apr-87	Disch	5m/Mid	B	0	0	0
21-Apr-87	Disch	5m/Mid	Combined	0	0	0
21-Apr-87	Disch	5m/Bot	A			
21-Apr-87	Disch	5m/Bot	B			
21-Apr-87	Disch	5m/Bot	Combined	0	0	0
21-Apr-87	Disch	7m/Surf	A	0	0	0
21-Apr-87	Disch	7m/Surf	B	0	0	0
21-Apr-87	Disch	7m/Surf	Combined	0	0	0
21-Apr-87	Disch	7m/Mid	A	0	0	0
21-Apr-87	Disch	7m/Mid	B	0	0	0
21-Apr-87	Disch	7m/Mid	Combined	0	0	0
21-Apr-87	Disch	7m/Bot	A			
21-Apr-87	Disch	7m/Bot	B			
21-Apr-87	Disch	7m/Bot	Combined	0	0	0
21-Apr-87	Disch	10m/Surf	A			
21-Apr-87	Disch	10m/Surf	B			
21-Apr-87	Disch	10m/Surf	Combined	0	0	0
21-Apr-87	Disch	10m/Mid	A			
21-Apr-87	Disch	10m/Mid	B			
21-Apr-87	Disch	10m/Mid	Combined	0	0	0
21-Apr-87	Disch	10m/Bot	A			
21-Apr-87	Disch	10m/Bot	B			
21-Apr-87	Disch	10m/Bot	Combined	0	0	0
21-Apr-87	Disch	12m/Surf	A	0	0	0
21-Apr-87	Disch	12m/Surf	B	0	0	0
21-Apr-87	Disch	12m/Surf	Combined	0	0	0
21-Apr-87	Disch	12m/Mid	A	0	0	0
21-Apr-87	Disch	12m/Mid	B	0	0	0
21-Apr-87	Disch	12m/Mid	Combined	0	0	0
21-Apr-87	Disch	12m/Bot	A			
21-Apr-87	Disch	12m/Bot	B			
21-Apr-87	Disch	12m/Bot	Combined	0	0	0

APPENDIX 3 CONTINUED
DARLINGTON 1987 LARVAL FISH CATCH DATA

DATE	LOCATION	DEPTH	NET	RWF	SHELT	OTHERS
23-Apr-87	Intake	5m/Surf	A	0	0	0
23-Apr-87	Intake	5m/Surf	B	0	0	0
23-Apr-87	Intake	5m/Surf	Combined	0	0	0
23-Apr-87	Intake	5m/Mid	A	0	0	0
23-Apr-87	Intake	5m/Mid	B	0	0	0
23-Apr-87	Intake	5m/Mid	Combined	0	0	0
23-Apr-87	Intake	5m/Bot	A	0	0	0
23-Apr-87	Intake	5m/Bot	B	0	0	0
23-Apr-87	Intake	5m/Bot	Combined	0	0	0
23-Apr-87	Intake	7m/Surf	A	0	0	0
23-Apr-87	Intake	7m/Surf	B	0	0	0
23-Apr-87	Intake	7m/Surf	Combined	0	0	0
23-Apr-87	Intake	7m/Mid	A	0	0	0
23-Apr-87	Intake	7m/Mid	B	0	0	0
23-Apr-87	Intake	7m/Mid	Combined	0	0	0
23-Apr-87	Intake	7m/Bot	A	0	0	3 sculpins
23-Apr-87	Intake	7m/Bot	B	0	0	0
23-Apr-87	Intake	7m/Bot	Combined	0	0	3 sculpins
23-Apr-87	Intake	10m/Surf	A	0	0	0
23-Apr-87	Intake	10m/Surf	B	0	0	0
23-Apr-87	Intake	10m/Surf	Combined	0	0	0
23-Apr-87	Intake	10m/Mid	A	0	0	0
23-Apr-87	Intake	10m/Mid	B	0	0	0
23-Apr-87	Intake	10m/Mid	Combined	0	0	0
23-Apr-87	Intake	10m/Bot	A	0	0	6 sculpins
23-Apr-87	Intake	10m/Bot	B	0	0	4 sculpins
23-Apr-87	Intake	10m/Bot	Combined	0	0	10 sculpins
23-Apr-87	Intake	12m/Surf	A	0	0	0
23-Apr-87	Intake	12m/Surf	B	0	0	0
23-Apr-87	Intake	12m/Surf	Combined	0	0	0
23-Apr-87	Intake	12m/Mid	A	0	0	0
23-Apr-87	Intake	12m/Mid	B	0	0	1 y.perch 6mm
23-Apr-87	Intake	12m/Mid	Combined	0	0	1 y.perch
23-Apr-87	Intake	12m/Bot	A	0	0	0
23-Apr-87	Intake	12m/Bot	B	0	0	0
23-Apr-87	Intake	12m/Bot	Combined	0	0	0

APPENDIX 3 CONTINUED
DARLINGTON 1987 LARVAL FISH CATCH DATA

DATE	LOCATION	DEPTH	NET	RWF		SHELT	OTHERS
23-Apr-87	Disch	5m/Surf	A	0		0	0
23-Apr-87	Disch	5m/Surf	B	0		0	0
23-Apr-87	Disch	5m/Surf	Combined	0		0	0
23-Apr-87	Disch	5m/Mid	A				
23-Apr-87	Disch	5m/Mid	B				
23-Apr-87	Disch	5m/Mid	Combined	0		0	0
23-Apr-87	Disch	5m/Bot	A	5	13,14,14,1	0	2 sculpins
23-Apr-87	Disch	5m/Bot	B	2	14.0, 15.0	0	0
23-Apr-87	Disch	5m/Bot	Combined	7		0	2 sculpins
23-Apr-87	Disch	7m/Surf	A	0		0	0
23-Apr-87	Disch	7m/Surf	B	0		0	0
23-Apr-87	Disch	7m/Surf	Combined	0		0	0
23-Apr-87	Disch	7m/Mid	A	0		0	0
23-Apr-87	Disch	7m/Mid	B	0		0	2 y.perch(6,6mm)
23-Apr-87	Disch	7m/Mid	Combined	0		0	2
23-Apr-87	Disch	7m/Bot	A	0		0	0
23-Apr-87	Disch	7m/Bot	B	0		0	8 sculpins
23-Apr-87	Disch	7m/Bot	Combined	0		0	8 sculpins
23-Apr-87	Disch	10m/Surf	A	0		0	0
23-Apr-87	Disch	10m/Surf	B	0		0	0
23-Apr-87	Disch	10m/Surf	Combined	0		0	0
23-Apr-87	Disch	10m/Mid	A	0		0	0
23-Apr-87	Disch	10m/Mid	B	0		0	0
23-Apr-87	Disch	10m/Mid	Combined	0		0	0
23-Apr-87	Disch	10m/Bot	A	1	13.0mm	0	11 sculpins
23-Apr-87	Disch	10m/Bot	B	0		0	2 sculpins
23-Apr-87	Disch	10m/Bot	Combined	1		0	13 sculpins
23-Apr-87	Disch	12m/Surf	A	0		0	0
23-Apr-87	Disch	12m/Surf	B	0		0	0
23-Apr-87	Disch	12m/Surf	Combined	0		0	0
23-Apr-87	Disch	12m/Mid	A	0		0	0
23-Apr-87	Disch	12m/Mid	B	0		0	0
23-Apr-87	Disch	12m/Mid	Combined	0		0	0
23-Apr-87	Disch	12m/Bot	A	0		0	20 sculpins
23-Apr-87	Disch	12m/Bot	B	0		0	12 sculpins
23-Apr-87	Disch	12m/Bot	Combined	0		0	32 sculpin

APPENDIX 3 CONTINUED

DARLINGTON 1987 LARVAL FISH CATCH DATA

DATE	LOCATION	DEPTH	NET	RWF	SHELT	OTHERS
28-Apr-87	Intake	5m/Surf	A	0	0	0
28-Apr-87	Intake	5m/Surf	B	0	0	0
28-Apr-87	Intake	5m/Surf	Combined	0	0	0
28-Apr-87	Intake	5m/Mid	A	0	0	0
28-Apr-87	Intake	5m/Mid	B	0	0	0
28-Apr-87	Intake	5m/Mid	Combined	0	0	0
29-Apr-87	Intake	5m/Bot	A	0	0	15 sculpins
29-Apr-87	Intake	5m/Bot	B	0	0	0
29-Apr-87	Intake	5m/Bot	Combined	0	0	15 sculpins
28-Apr-87	Intake	7m/Surf	A	0	0	0
28-Apr-87	Intake	7m/Surf	B	0	0	0
28-Apr-87	Intake	7m/Surf	Combined	0	0	0
28-Apr-87	Intake	7m/Mid	A	0	0	0
28-Apr-87	Intake	7m/Mid	B	0	0	0
28-Apr-87	Intake	7m/Mid	Combined	0	0	0
29-Apr-87	Intake	7m/Bot	A	0	0	0
29-Apr-87	Intake	7m/Bot	B	0	0	2 sculpins
29-Apr-87	Intake	7m/Bot	Combined	0	0	2 sculpins
28-Apr-87	Intake	10m/Surf	A	0	0	0
28-Apr-87	Intake	10m/Surf	B	0	0	0
28-Apr-87	Intake	10m/Surf	Combined	0	0	0
28-Apr-87	Intake	10m/Mid	A	0	0	0
28-Apr-87	Intake	10m/Mid	B	0	0	0
28-Apr-87	Intake	10m/Mid	Combined	0	0	0
29-Apr-87	Intake	10m/Bot	A	0	0	0
29-Apr-87	Intake	10m/Bot	B	0	0	1 sculpin
29-Apr-87	Intake	10m/Bot	Combined	0	0	1 sculpin
28-Apr-87	Intake	12m/Surf	A	0	0	0
28-Apr-87	Intake	12m/Surf	B	0	0	0
28-Apr-87	Intake	12m/Surf	Combined	0	0	0
28-Apr-87	Intake	12m/Mid	A	0	0	0
28-Apr-87	Intake	12m/Mid	B	0	0	1 sculpin
28-Apr-87	Intake	12m/Mid	Combined	0	0	1 sculpin
29-Apr-87	Intake	12m/Bot	A	0	0	0
29-Apr-87	Intake	12m/Bot	B	0	0	0
29-Apr-87	Intake	12m/Bot	Combined	0	0	0

APPENDIX 3 CONTINUED
DARLINGTON 1987 LARVAL FISH CATCH DATA

DATE	LOCATION	DEPTH	NET	RWF	SHELT	OTHERS
28-Apr-87	Disch	5m/Surf	A			
28-Apr-87	Disch	5m/Surf	B			
28-Apr-87	Disch	5m/Surf	Combined	0	0	0
28-Apr-87	Disch	5m/Mid	A			
28-Apr-87	Disch	5m/Mid	B			
28-Apr-87	Disch	5m/Mid	Combined	0	0	0
29-Apr-87	Disch	5m/Bot	A	0	0	0
29-Apr-87	Disch	5m/Bot	B	0	0	2 sculpins
29-Apr-87	Disch	5m/Bot	Combined	0	0	2 sculpins
28-Apr-87	Disch	7m/Surf	A			
28-Apr-87	Disch	7m/Surf	B			
28-Apr-87	Disch	7m/Surf	Combined	0	0	0
28-Apr-87	Disch	7m/Mid	A			
28-Apr-87	Disch	7m/Mid	B			
28-Apr-87	Disch	7m/Mid	Combined	0	0	0
29-Apr-87	Disch	7m/Bot	A			
29-Apr-87	Disch	7m/Bot	B			
29-Apr-87	Disch	7m/Bot	Combined	0	0	0
28-Apr-87	Disch	10m/Surf	A			
28-Apr-87	Disch	10m/Surf	B			
28-Apr-87	Disch	10m/Surf	Combined	0	0	0
28-Apr-87	Disch	10m/Mid	A			
28-Apr-87	Disch	10m/Mid	B			
28-Apr-87	Disch	10m/Mid	Combined	0	0	0
29-Apr-87	Disch	10m/Bot	A			
29-Apr-87	Disch	10m/Bot	B			
29-Apr-87	Disch	10m/Bot	Combined	0	0	0
28-Apr-87	Disch	12m/Surf	A	0	0	0
28-Apr-87	Disch	12m/Surf	B	0	0	0
28-Apr-87	Disch	12m/Surf	Combined	0	0	0
28-Apr-87	Disch	12m/Mid	A	0	0	0
28-Apr-87	Disch	12m/Mid	B	0	0	0
28-Apr-87	Disch	12m/Mid	Combined	0	0	0
29-Apr-87	Disch	12m/Bot	A			
29-Apr-87	Disch	12m/Bot	B			
29-Apr-87	Disch	12m/Bot	Combined	0	0	0

APPENDIX 3 CONTINUED

DARLINGTON 1987 LARVAL FISH CATCH DATA

DATE	LOCATION	DEPTH	NET	RWF	SHELT	OTHERS
30-Apr-87	Intake	5m/Surf	A	0	0	0
30-Apr-87	Intake	5m/Surf	B	0	0	0
30-Apr-87	Intake	5m/Surf	Combined	0	0	0
30-Apr-87	Intake	5m/Mid	A	0	0	0
30-Apr-87	Intake	5m/Mid	B	0	0	0
30-Apr-87	Intake	5m/Mid	Combined	0	0	0
30-Apr-87	Intake	5m/Bot	A			
30-Apr-87	Intake	5m/Bot	B			
30-Apr-87	Intake	5m/Bot	Combined	0	0	0
30-Apr-87	Intake	7m/Surf	A	0	0	0
30-Apr-87	Intake	7m/Surf	B	0	0	0
30-Apr-87	Intake	7m/Surf	Combined	0	0	0
30-Apr-87	Intake	7m/Mid	A	0	0	0
30-Apr-87	Intake	7m/Mid	B	0	0	0
30-Apr-87	Intake	7m/Mid	Combined	0	0	0
30-Apr-87	Intake	7m/Bot	A			
30-Apr-87	Intake	7m/Bot	B			
30-Apr-87	Intake	7m/Bot	Combined	0	0	0
30-Apr-87	Intake	10m/Surf	A	0	0	0
30-Apr-87	Intake	10m/Surf	B	0	0	0
30-Apr-87	Intake	10m/Surf	Combined	0	0	0
30-Apr-87	Intake	10m/Mid	A	0	0	0
30-Apr-87	Intake	10m/Mid	B	0	0	0
30-Apr-87	Intake	10m/Mid	Combined	0	0	0
30-Apr-87	Intake	10m/Bot	A			
30-Apr-87	Intake	10m/Bot	B			
30-Apr-87	Intake	10m/Bot	Combined	0	0	0
30-Apr-87	Intake	12m/Surf	A	0	0	0
30-Apr-87	Intake	12m/Surf	B	0	0	0
30-Apr-87	Intake	12m/Surf	Combined	0	0	0
30-Apr-87	Intake	12m/Mid	A	0	0	0
30-Apr-87	Intake	12m/Mid	B	0	0	0
30-Apr-87	Intake	12m/Mid	Combined	0	0	0
30-Apr-87	Intake	12m/Bot	A			
30-Apr-87	Intake	12m/Bot	B			
30-Apr-87	Intake	12m/Bot	Combined	0	0	0

APPENDIX 3 CONTINUED
DARLINGTON 1987 LARVAL FISH CATCH DATA

DATE	LOCATION	DEPTH	NET	RWF	SHELT	OTHERS
30-Apr-87	Disch	5m/Surf	A	0	0	0
30-Apr-87	Disch	5m/Surf	B	0	0	0
30-Apr-87	Disch	5m/Surf	Combined	0	0	0
30-Apr-87	Disch	5m/Mid	A	0	0	0
30-Apr-87	Disch	5m/Mid	B	0	0	0
30-Apr-87	Disch	5m/Mid	Combined	0	0	0
30-Apr-87	Disch	5m/Bot	A			
30-Apr-87	Disch	5m/Bot	B			
30-Apr-87	Disch	5m/Bot	Combined	0	0	0
30-Apr-87	Disch	7m/Surf	A	0	0	0
30-Apr-87	Disch	7m/Surf	B	0	0	0
30-Apr-87	Disch	7m/Surf	Combined	0	0	0
30-Apr-87	Disch	7m/Mid	A	0	0	0
30-Apr-87	Disch	7m/Mid	B	0	0	0
30-Apr-87	Disch	7m/Mid	Combined	0	0	0
30-Apr-87	Disch	7m/Bot	A	0	0	7 sculpins
30-Apr-87	Disch	7m/Bot	B	0	0	1 sculpins
30-Apr-87	Disch	7m/Bot	Combined	0	0	8 sculpins
30-Apr-87	Disch	10m/Surf	A	0	0	0
30-Apr-87	Disch	10m/Surf	B	0	0	0
30-Apr-87	Disch	10m/Surf	Combined	0	0	0
30-Apr-87	Disch	10m/Mid	A	0	0	0
30-Apr-87	Disch	10m/Mid	B	0	0	0
30-Apr-87	Disch	10m/Mid	Combined	0	0	0
30-Apr-87	Disch	10m/Bot	A	0	0	0
30-Apr-87	Disch	10m/Bot	B	0	0	15 sculpins
30-Apr-87	Disch	10m/Bot	Combined	0	0	15 sculpins
30-Apr-87	Disch	12m/Surf	A	0	0	0
30-Apr-87	Disch	12m/Surf	B	0	0	0
30-Apr-87	Disch	12m/Surf	Combined	0	0	0
30-Apr-87	Disch	12m/Mid	A	0	0	0
30-Apr-87	Disch	12m/Mid	B	0	0	0
30-Apr-87	Disch	12m/Mid	Combined	0	0	0
30-Apr-87	Disch	12m/Bot	A	0	0	13 sculpins
30-Apr-87	Disch	12m/Bot	B	0	0	1 sculpin
30-Apr-87	Disch	12m/Bot	Combined	0	0	14 sculpins

APPENDIX 3 CONTINUED
DARLINGTON 1987 LARVAL FISH CATCH DATA

DATE	LOCATION	DEPTH	NET	RWF	SHELT	OTHERS
04-May-87	Intake	5m/Surf	A	0	0	0
04-May-87	Intake	5m/Surf	B	0	0	0
04-May-87	Intake	5m/Surf	Combined	0	0	0
04-May-87	Intake	5m/Mid	A	0	0	0
04-May-87	Intake	5m/Mid	B	0	0	0
04-May-87	Intake	5m/Mid	Combined	0	0	0
05-May-87	Intake	5m/Bot	A	0	0	4 sculpins
05-May-87	Intake	5m/Bot	B	0	0	5 sculpins
05-May-87	Intake	5m/Bot	Combined	0	0	9 sculpins
04-May-87	Intake	7m/Surf	A	0	0	0
04-May-87	Intake	7m/Surf	B	0	0	0
04-May-87	Intake	7m/Surf	Combined	0	0	0
04-May-87	Intake	7m/Mid	A	0	0	0
04-May-87	Intake	7m/Mid	B	0	0	0
04-May-87	Intake	7m/Mid	Combined	0	0	0
05-May-87	Intake	7m/Bot	A	0	0	0
05-May-87	Intake	7m/Bot	B	0	0	0
05-May-87	Intake	7m/Bot	Combined	0	0	0
04-May-87	Intake	10m/Surf	A	0	0	0
04-May-87	Intake	10m/Surf	B	0	0	0
04-May-87	Intake	10m/Surf	Combined	0	0	0
04-May-87	Intake	10m/Mid	A	0	0	0
04-May-87	Intake	10m/Mid	B	0	0	0
04-May-87	Intake	10m/Mid	Combined	0	0	0
05-May-87	Intake	10m/Bot	A	0	0	3 sculpins
05-May-87	Intake	10m/Bot	B	0	0	0
05-May-87	Intake	10m/Bot	Combined	0	0	3 sculpins
04-May-87	Intake	12m/Surf	A	0	0	0
04-May-87	Intake	12m/Surf	B	0	0	0
04-May-87	Intake	12m/Surf	Combined	0	0	0
04-May-87	Intake	12m/Mid	A	0	0	0
04-May-87	Intake	12m/Mid	B	0	0	0
04-May-87	Intake	12m/Mid	Combined	0	0	0
05-May-87	Intake	12m/Bot	A	0	0	0
05-May-87	Intake	12m/Bot	B	0	0	0
05-May-87	Intake	12m/Bot	Combined	0	0	0

APPENDIX 3 CONTINUED
DARLINGTON 1987 LARVAL FISH CATCH DATA

DATE	LOCATION	DEPTH	NET	RWF		SHELT	OTHERS
04-May-87	Disch	5m/Surf	A	0		0	0
04-May-87	Disch	5m/Surf	B	0		0	0
04-May-87	Disch	5m/Surf	Combined	0		0	0
04-May-87	Disch	5m/Mid	A	0		0	0
04-May-87	Disch	5m/Mid	B	0		0	1 y.perch (5.0mm)
04-May-87	Disch	5m/Mid	Combined	0		0	1 y.perch
05-May-87	Disch	5m/Bot	A	1	20.0 mm	0	9 sculpins
05-May-87	Disch	5m/Bot	B	0		0	5 sculpins
05-May-87	Disch	5m/Bot	Combined	1		0	14 sculpins
04-May-87	Disch	7m/Surf	A	0		0	0
04-May-87	Disch	7m/Surf	B	0		0	0
04-May-87	Disch	7m/Surf	Combined	0		0	0
04-May-87	Disch	7m/Mid	A	0		0	0
04-May-87	Disch	7m/Mid	B	0		0	0
04-May-87	Disch	7m/Mid	Combined	0		0	0
05-May-87	Disch	7m/Bot	A	2	15, 16mm	0	6 sculpins
05-May-87	Disch	7m/Bot	B	0		0	0
05-May-87	Disch	7m/Bot	Combined	2		0	6 sculpins
04-May-87	Disch	10m/Surf	A	0		0	0
04-May-87	Disch	10m/Surf	B	0		0	0
04-May-87	Disch	10m/Surf	Combined	0		0	0
04-May-87	Disch	10m/Mid	A	0		0	0
04-May-87	Disch	10m/Mid	B	0		0	0
04-May-87	Disch	10m/Mid	Combined	0		0	0
05-May-87	Disch	10m/Bot	A	0		0	1 sculpin
05-May-87	Disch	10m/Bot	B	0		0	5 sculpins
05-May-87	Disch	10m/Bot	Combined	0		0	6 sculpins
04-May-87	Disch	12m/Surf	A	0		0	0
04-May-87	Disch	12m/Surf	B	0		0	0
04-May-87	Disch	12m/Surf	Combined	0		0	0
04-May-87	Disch	12m/Mid	A	0		0	0
04-May-87	Disch	12m/Mid	B	0		0	0
04-May-87	Disch	12m/Mid	Combined	0		0	0
05-May-87	Disch	12m/Bot	A	0		0	1 sculpin
05-May-87	Disch	12m/Bot	B	0		0	1 sculpin
05-May-87	Disch	12m/Bot	Combined	0		0	2 sculpins

APPENDIX 3 CONTINUED
DARLINGTON 1987 LARVAL FISH CATCH DATA

DATE	LOCATION	DEPTH	NET	RWF	SHELT	OTHERS
06-May-87	Intake	5m/Surf	A	0	0	0
06-May-87	Intake	5m/Surf	B	0	0	0
06-May-87	Intake	5m/Surf	Combined	0	0	0
06-May-87	Intake	5m/Mid	A	0	0	0
06-May-87	Intake	5m/Mid	B	0	0	0
06-May-87	Intake	5m/Mid	Combined	0	0	0
06-May-87	Intake	5m/Bot	A			
06-May-87	Intake	5m/Bot	B			
06-May-87	Intake	5m/Bot	Combined	0	0	0
06-May-87	Intake	7m/Surf	A	0	0	0
06-May-87	Intake	7m/Surf	B	0	0	0
06-May-87	Intake	7m/Surf	Combined	0	0	0
06-May-87	Intake	7m/Mid	A	0	0	0
06-May-87	Intake	7m/Mid	B	0	0	0
06-May-87	Intake	7m/Mid	Combined	0	0	0
06-May-87	Intake	7m/Bot	A			
06-May-87	Intake	7m/Bot	B			
06-May-87	Intake	7m/Bot	Combined	0	0	0
06-May-87	Intake	10m/Surf	A	0	0	0
06-May-87	Intake	10m/Surf	B	0	0	0
06-May-87	Intake	10m/Surf	Combined	0	0	0
06-May-87	Intake	10m/Mid	A	0	0	0
06-May-87	Intake	10m/Mid	B	0	0	0
06-May-87	Intake	10m/Mid	Combined	0	0	0
06-May-87	Intake	10m/Bot	A			
06-May-87	Intake	10m/Bot	B			
06-May-87	Intake	10m/Bot	Combined	0	0	0
06-May-87	Intake	12m/Surf	A	0	0	0
06-May-87	Intake	12m/Surf	B	0	0	0
06-May-87	Intake	12m/Surf	Combined	0	0	0
06-May-87	Intake	12m/Mid	A	0	0	0
06-May-87	Intake	12m/Mid	B	0	0	0
06-May-87	Intake	12m/Mid	Combined	0	0	0
06-May-87	Intake	12m/Bot	A			
06-May-87	Intake	12m/Bot	B			
06-May-87	Intake	12m/Bot	Combined	0	0	0

APPENDIX 3 CONTINUED
DARLINGTON 1987 LARVAL FISH CATCH DATA

DATE	LOCATION	DEPTH	NET	RWF	SMELT	OTHERS
06-May-87	Disch	5m/Surf	A	0	0	0
06-May-87	Disch	5m/Surf	B	0	0	0
06-May-87	Disch	5m/Surf	Combined	0	0	0
06-May-87	Disch	5m/Mid	A	0	0	0
06-May-87	Disch	5m/Mid	B	0	0	0
06-May-87	Disch	5m/Mid	Combined	0	0	0
06-May-87	Disch	5m/Bot	A			
06-May-87	Disch	5m/Bot	B			
06-May-87	Disch	5m/Bot	Combined	0	0	0
06-May-87	Disch	7m/Surf	A	0	0	0
06-May-87	Disch	7m/Surf	B	0	0	0
06-May-87	Disch	7m/Surf	Combined	0	0	0
06-May-87	Disch	7m/Mid	A	0	0	0
06-May-87	Disch	7m/Mid	B	0	0	0
06-May-87	Disch	7m/Mid	Combined	0	0	0
06-May-87	Disch	7m/Bot	A			
06-May-87	Disch	7m/Bot	B			
06-May-87	Disch	7m/Bot	Combined	0	0	0
06-May-87	Disch	10m/Surf	A	0	0	0
06-May-87	Disch	10m/Surf	B	0	0	0
06-May-87	Disch	10m/Surf	Combined	0	0	0
06-May-87	Disch	10m/Mid	A	0	0	0
06-May-87	Disch	10m/Mid	B	0	0	0
06-May-87	Disch	10m/Mid	Combined	0	0	0
06-May-87	Disch	10m/Bot	A			
06-May-87	Disch	10m/Bot	B			
06-May-87	Disch	10m/Bot	Combined	0	0	0
06-May-87	Disch	12m/Surf	A	0	0	0
06-May-87	Disch	12m/Surf	B	0	0	0
06-May-87	Disch	12m/Surf	Combined	0	0	0
06-May-87	Disch	12m/Mid	A	0	0	0
06-May-87	Disch	12m/Mid	B	0	0	0
06-May-87	Disch	12m/Mid	Combined	0	0	0
06-May-87	Disch	12m/Bot	A			
06-May-87	Disch	12m/Bot	B			
06-May-87	Disch	12m/Bot	Combined	0	0	0

APPENDIX 3 CONTINUED
DARLINGTON 1987 LARVAL FISH CATCH DATA

DATE	LOCATION	DEPTH	NET	RWF	SHELT	OTHERS
12-May-87	Intake	5m/Surf	A	0	0	0
12-May-87	Intake	5m/Surf	B	0	0	0
12-May-87	Intake	5m/Surf	Combined	0	0	0
14-May-87	Intake	5m/Mid	A	0	0	0
14-May-87	Intake	5m/Mid	B	0	0	0
14-May-87	Intake	5m/Mid	Combined	0	0	0
12-May-87	Intake	5m/Bot	A	0	0	5 sculpins
12-May-87	Intake	5m/Bot	B	0	0	19 sculpins
12-May-87	Intake	5m/Bot	Combined	0	0	24 sculpins
12-May-87	Intake	7m/Surf	A	0	0	0
12-May-87	Intake	7m/Surf	B	0	0	0
12-May-87	Intake	7m/Surf	Combined	0	0	0
14-May-87	Intake	7m/Mid	A	0	0	0
14-May-87	Intake	7m/Mid	B	0	0	0
14-May-87	Intake	7m/Mid	Combined	0	0	0
12-May-87	Intake	7m/Bot	A	0	0	9 sculpins
12-May-87	Intake	7m/Bot	B	0	0	23 sculpins
12-May-87	Intake	7m/Bot	Combined	0	0	32 sculpins
12-May-87	Intake	10m/Surf	A	0	0	0
12-May-87	Intake	10m/Surf	B	0	0	0
12-May-87	Intake	10m/Surf	Combined	0	0	0
14-May-87	Intake	10m/Mid	A	0	0	0
14-May-87	Intake	10m/Mid	B	0	0	0
14-May-87	Intake	10m/Mid	Combined	0	0	0
12-May-87	Intake	10m/Bot	A	0	0	4 sculpins
12-May-87	Intake	10m/Bot	B	0	0	13 sculpins
12-May-87	Intake	10m/Bot	Combined	0	0	17 sculpins
12-May-87	Intake	12m/Surf	A	0	0	0
12-May-87	Intake	12m/Surf	B	0	0	0
12-May-87	Intake	12m/Surf	Combined	0	0	0
14-May-87	Intake	12m/Mid	A	0	0	0
14-May-87	Intake	12m/Mid	B	0	0	0
14-May-87	Intake	12m/Mid	Combined	0	0	0
12-May-87	Intake	12m/Bot	A	0	0	1 sculpin
12-May-87	Intake	12m/Bot	B	0	0	0
12-May-87	Intake	12m/Bot	Combined	0	0	1 sculpin

APPENDIX 3 CONTINUED

DARLINGTON 1987 LARVAL FISH CATCH DATA

DATE	LOCATION	DEPTH	NET	RNF	SMELT	OTHERS
12-May-87	Disch	5m/Surf	A	0	0	0
12-May-87	Disch	5m/Surf	B	0	0	0
12-May-87	Disch	5m/Surf	Combined	0	0	0
14-May-87	Disch	5m/Mid	A	0	0	0
14-May-87	Disch	5m/Mid	B	0	0	0
14-May-87	Disch	5m/Mid	Combined	0	0	0
12-May-87	Disch	5m/Bot	A	0	0	0
12-May-87	Disch	5m/Bot	B	0	0	0
12-May-87	Disch	5m/Bot	Combined	0	0	0
12-May-87	Disch	7m/Surf	A	0	0	0
12-May-87	Disch	7m/Surf	B	0	0	0
12-May-87	Disch	7m/Surf	Combined	0	0	0
14-May-87	Disch	7m/Mid	A	0	0	0
14-May-87	Disch	7m/Mid	B	0	0	0
14-May-87	Disch	7m/Mid	Combined	0	0	0
12-May-87	Disch	7m/Bot	A	0	0	0
12-May-87	Disch	7m/Bot	B	0	0	1 sculpin
12-May-87	Disch	7m/Bot	Combined	0	0	1
12-May-87	Disch	10m/Surf	A	0	0	0
12-May-87	Disch	10m/Surf	B	0	0	0
12-May-87	Disch	10m/Surf	Combined	0	0	0
14-May-87	Disch	10m/Mid	A	0	0	0
14-May-87	Disch	10m/Mid	B	0	0	0
14-May-87	Disch	10m/Mid	Combined	0	0	0
12-May-87	Disch	10m/Bot	A	0	0	0
12-May-87	Disch	10m/Bot	B	0	0	1 sculpin
12-May-87	Disch	10m/Bot	Combined	0	0	1
12-May-87	Disch	12m/Surf	A	0	0	0
12-May-87	Disch	12m/Surf	B	0	0	0
12-May-87	Disch	12m/Surf	Combined	0	0	0
14-May-87	Disch	12m/Mid	A	0	0	0
14-May-87	Disch	12m/Mid	B	0	0	0
14-May-87	Disch	12m/Mid	Combined	0	0	0
12-May-87	Disch	12m/Bot	A	0	0	0
12-May-87	Disch	12m/Bot	B	0	0	0
12-May-87	Disch	12m/Bot	Combined	0	0	0

APPENDIX 3 CONTINUED
DARLINGTON 1987 LARVAL FISH CATCH DATA

DATE	LOCATION	DEPTH	NET	RWF	SHELT	OTHERS
13-May-87	Intake	5m/Surf	A	0	0	0
13-May-87	Intake	5m/Surf	B	0	0	0
13-May-87	Intake	5m/Surf	Combined	0	0	0
13-May-87	Intake	5m/Mid	A	0	0	0
13-May-87	Intake	5m/Mid	B	0	0	0
13-May-87	Intake	5m/Mid	Combined	0	0	0
13-May-87	Intake	5m/Bot	A			
13-May-87	Intake	5m/Bot	B			
13-May-87	Intake	5m/Bot	Combined	0	0	0
13-May-87	Intake	7m/Surf	A	0	0	0
13-May-87	Intake	7m/Surf	B	0	0	0
13-May-87	Intake	7m/Surf	Combined	0	0	0
13-May-87	Intake	7m/Mid	A	0	0	0
13-May-87	Intake	7m/Mid	B	0	0	0
13-May-87	Intake	7m/Mid	Combined	0	0	0
13-May-87	Intake	7m/Bot	A			
13-May-87	Intake	7m/Bot	B			
13-May-87	Intake	7m/Bot	Combined	0	0	0
13-May-87	Intake	10m/Surf	A	0	0	0
13-May-87	Intake	10m/Surf	B	0	0	0
13-May-87	Intake	10m/Surf	Combined	0	0	0
13-May-87	Intake	10m/Mid	A	0	0	0
13-May-87	Intake	10m/Mid	B	0	0	0
13-May-87	Intake	10m/Mid	Combined	0	0	0
13-May-87	Intake	10m/Bot	A			
13-May-87	Intake	10m/Bot	B			
13-May-87	Intake	10m/Bot	Combined	0	0	0
13-May-87	Intake	12m/Surf	A	0	0	0
13-May-87	Intake	12m/Surf	B	0	0	0
13-May-87	Intake	12m/Surf	Combined	0	0	0
13-May-87	Intake	12m/Mid	A	0	0	0
13-May-87	Intake	12m/Mid	B	0	0	0
13-May-87	Intake	12m/Mid	Combined	0	0	0
13-May-87	Intake	12m/Bot	A			
13-May-87	Intake	12m/Bot	B			
13-May-87	Intake	12m/Bot	Combined	0	0	0

APPENDIX 3 CONTINUED

DARLINGTON 1987 LARVAL FISH CATCH DATA

DATE	LOCATION	DEPTH	NET	RNF	SHELT		OTHERS
13-May-87	Disch	5m/Surf	A	0	0		0
13-May-87	Disch	5m/Surf	B	0	0		0
13-May-87	Disch	5m/Surf	Combined	0	0		0
13-May-87	Disch	5m/Mid	A	0	1	5.5mm	0
13-May-87	Disch	5m/Mid	B	0	0		0
13-May-87	Disch	5m/Mid	Combined	0	1		0
13-May-87	Disch	5m/Bot	A				
13-May-87	Disch	5m/Bot	B				
13-May-87	Disch	5m/Bot	Combined	0	0		0
13-May-87	Disch	7m/Surf	A	0	0		0
13-May-87	Disch	7m/Surf	B	0	0		0
13-May-87	Disch	7m/Surf	Combined	0	0		0
13-May-87	Disch	7m/Mid	A	0	0		0
13-May-87	Disch	7m/Mid	B	0	0		0
13-May-87	Disch	7m/Mid	Combined	0	0		0
13-May-87	Disch	7m/Bot	A				
13-May-87	Disch	7m/Bot	B				
13-May-87	Disch	7m/Bot	Combined	0	0		0
13-May-87	Disch	10m/Surf	A	0	0		0
13-May-87	Disch	10m/Surf	B	0	0		0
13-May-87	Disch	10m/Surf	Combined	0	0		0
13-May-87	Disch	10m/Mid	A	0	0		0
13-May-87	Disch	10m/Mid	B	0	0		0
13-May-87	Disch	10m/Mid	Combined	0	0		0
13-May-87	Disch	10m/Bot	A				
13-May-87	Disch	10m/Bot	B				
13-May-87	Disch	10m/Bot	Combined	0	0		0
13-May-87	Disch	12m/Surf	A	0	0		0
13-May-87	Disch	12m/Surf	B	0	0		0
13-May-87	Disch	12m/Surf	Combined	0	0		0
13-May-87	Disch	12m/Mid	A	0	0		0
13-May-87	Disch	12m/Mid	B	0	0		0
13-May-87	Disch	12m/Mid	Combined	0	0		0
13-May-87	Disch	12m/Bot	A				
13-May-87	Disch	12m/Bot	B				
13-May-87	Disch	12m/Bot	Combined	0	0		0

APPENDIX 3 CONTINUED
DARLINGTON 1987 LARVAL FISH CATCH DATA

DATE	LOCATION	DEPTH	NET	RWF	SHELT		OTHERS
21-May-87	Intake	5m/Surf	A	0	0		0
21-May-87	Intake	5m/Surf	B	0	4	5-5.5mm	0
21-May-87	Intake	5m/Surf	Combined	0	4		0
21-May-87	Intake	5m/Mid	A	0	1	5.0 mm	0
21-May-87	Intake	5m/Mid	B	0	8	5-6mm	0
21-May-87	Intake	5m/Mid	Combined	0	9		0
21-May-87	Intake	5m/Bot	A	0	0		4 sculpins
21-May-87	Intake	5m/Bot	B	0	0		5 sculpins
21-May-87	Intake	5m/Bot	Combined	0	0		9 sculpins
21-May-87	Intake	7m/Surf	A	0	0		0
21-May-87	Intake	7m/Surf	B	0	1	6.0mm	0
21-May-87	Intake	7m/Surf	Combined	0	1		0
21-May-87	Intake	7m/Mid	A	0	1	5.5 mm	0
21-May-87	Intake	7m/Mid	B	0	2	5.5,6mm	0
21-May-87	Intake	7m/Mid	Combined	0	3		0
21-May-87	Intake	7m/Bot	A	0	0		6 sculpins
21-May-87	Intake	7m/Bot	B	0	0		0
21-May-87	Intake	7m/Bot	Combined	0	0		6 sculpins
21-May-87	Intake	10m/Surf	A	0	2	5.5,6mm	0
21-May-87	Intake	10m/Surf	B	0	4	5-6mm	0
21-May-87	Intake	10m/Surf	Combined	0	6		0
21-May-87	Intake	10m/Mid	A	0	1	5.0 mm	0
21-May-87	Intake	10m/Mid	B	0	0		0
21-May-87	Intake	10m/Mid	Combined	0	1		0
21-May-87	Intake	10m/Bot	A	0	0		4 sculpin egg
21-May-87	Intake	10m/Bot	B	0	0		6 sculpins
21-May-87	Intake	10m/Bot	Combined	0	0		10 sculpins
21-May-87	Intake	12m/Surf	A	0	19	5-7mm	0
21-May-87	Intake	12m/Surf	B	0	8	5-6mm	0
21-May-87	Intake	12m/Surf	Combined	0	27		0
21-May-87	Intake	12m/Mid	A	0	11	5-5.5mm	0
21-May-87	Intake	12m/Mid	B	0	8	5-5.5mm	0
21-May-87	Intake	12m/Mid	Combined	0	19		0
21-May-87	Intake	12m/Bot	A	0	0		9 sculpins
21-May-87	Intake	12m/Bot	B	0	0		0
21-May-87	Intake	12m/Bot	Combined	0	0		9 sculpins

APPENDIX 3 CONTINUED
DARLINGTON 1987 LARVAL FISH CATCH DATA

DATE	LOCATION	DEPTH	NET	RWF		SHELT		OTHERS	
21-May-87	Disch	5m/Surf	A	0		0		0	
21-May-87	Disch	5m/Surf	B	0		9	5-6mm	0	
21-May-87	Disch	5m/Surf	Combined	0		9		0	
21-May-87	Disch	5m/Mid	A	0		10	5-5.5mm	0	
21-May-87	Disch	5m/Mid	B	0		12	5-6mm	0	
21-May-87	Disch	5m/Mid	Combined	0		22		0	
21-May-87	Disch	5m/Bot	A	1	24.0mm	0		8 sculpins	
21-May-87	Disch	5m/Bot	B	0		0		16 sculpins	
21-May-87	Disch	5m/Bot	Combined	1		0		24 sculpins	
21-May-87	Disch	7m/Surf	A	0		8	5-6mm	0	
21-May-87	Disch	7m/Surf	B	0		8	5-6mm	0	
21-May-87	Disch	7m/Surf	Combined	0		16		0	
21-May-87	Disch	7m/Mid	A	0		2	5.5,6mm	0	
21-May-87	Disch	7m/Mid	B	0		0		0	
21-May-87	Disch	7m/Mid	Combined	0		2		0	
21-May-87	Disch	7m/Bot	A	0		1	long dead	0	
21-May-87	Disch	7m/Bot	B	0		0		0	
21-May-87	Disch	7m/Bot	Combined	0		1		0	
21-May-87	Disch	10m/Surf	A	0		5	5.5-6mm	0	
21-May-87	Disch	10m/Surf	B	0		1	5.5mm	0	
21-May-87	Disch	10m/Surf	Combined	0		6		0	11 sculpin
21-May-87	Disch	10m/Mid	A	0		6	5-5.5mm	0	
21-May-87	Disch	10m/Mid	B	0		1	5.0mm	0	
21-May-87	Disch	10m/Mid	Combined	0		7		0	
21-May-87	Disch	10m/Bot	A	0		0		1 sculpin	
21-May-87	Disch	10m/Bot	B	0		0		1 sculpin	
21-May-87	Disch	10m/Bot	Combined	0		0		2 sculpins	
21-May-87	Disch	12m/Surf	A	0		29	5.5-6mm	0	
21-May-87	Disch	12m/Surf	B	0		38	5-6mm	0	
21-May-87	Disch	12m/Surf	Combined	0		67		0	
21-May-87	Disch	12m/Mid	A	0		4	5-6mm	0	
21-May-87	Disch	12m/Mid	B	0		10	5-7.5mm	0	
21-May-87	Disch	12m/Mid	Combined	0		14		0	
21-May-87	Disch	12m/Bot	A	0		0		1 sculpin	
21-May-87	Disch	12m/Bot	B	0		0		1 sculpin	
21-May-87	Disch	12m/Bot	Combined	0		0		2 sculpins	

APPENDIX 4
DARLINGTON 1988 LARVAL FISH CATCH DATA

DATE	LOCATION	DEPTH	NET	RWF	SHELT	OTHERS
21-Apr-88	Intake	5m/Surf	A	0	0	0
21-Apr-88	Intake	5m/Surf	B	0	0	0
21-Apr-88	Intake	5m/Surf	Combined	0	0	0
21-Apr-88	Intake	5m/Mid	A			
21-Apr-88	Intake	5m/Mid	B			
21-Apr-88	Intake	5m/Mid	Combined	0	0	0
21-Apr-88	Intake	5m/Bot	A	0	0	4 sculpins
21-Apr-88	Intake	5m/Bot	B	0	0	10 sculpins
21-Apr-88	Intake	5m/Bot	Combined	0	0	14 sculpins
21-Apr-88	Intake	7m/Surf	A	0	0	0
21-Apr-88	Intake	7m/Surf	B	0	0	0
21-Apr-88	Intake	7m/Surf	Combined	0	0	0
21-Apr-88	Intake	7m/Mid	A			
21-Apr-88	Intake	7m/Mid	B			
21-Apr-88	Intake	7m/Mid	Combined	0	0	0
21-Apr-88	Intake	7m/Bot	A	0	0	9 sculpins
21-Apr-88	Intake	7m/Bot	B	0	0	8 sculpins
21-Apr-88	Intake	7m/Bot	Combined	0	0	17 sculpins
21-Apr-88	Intake	10m/Surf	A	0	0	0
21-Apr-88	Intake	10m/Surf	B	0	0	0
21-Apr-88	Intake	10m/Surf	Combined	0	0	0
21-Apr-88	Intake	10m/Mid	A	0	0	0
21-Apr-88	Intake	10m/Mid	B	0	0	0
21-Apr-88	Intake	10m/Mid	Combined	0	0	0
21-Apr-88	Intake	10m/Bot	A	0	0	0
21-Apr-88	Intake	10m/Bot	B	0	0	0
21-Apr-88	Intake	10m/Bot	Combined	0	0	0
21-Apr-88	Intake	12m/Surf	A	0	0	0
21-Apr-88	Intake	12m/Surf	B	0	0	0
21-Apr-88	Intake	12m/Surf	Combined	0	0	0
21-Apr-88	Intake	12m/Mid	A	0	0	0
21-Apr-88	Intake	12m/Mid	B	0	0	0
21-Apr-88	Intake	12m/Mid	Combined	0	0	0
21-Apr-88	Intake	12m/Bot	A	0	0	1 sculpin
21-Apr-88	Intake	12m/Bot	B	0	0	1 sculpin
21-Apr-88	Intake	12m/Bot	Combined	0	0	2 sculpins

APPENDIX 4 CONTINUED
DARLINGTON 1988 LARVAL FISH CATCH DATA

DATE	LOCATION	DEPTH	NET	RNF	SHELT	OTHERS
21-Apr-88	Disch	5m/Surf	A	0	0	0
21-Apr-88	Disch	5m/Surf	B	0	0	0
21-Apr-88	Disch	5m/Surf	Combined	0	0	0
21-Apr-88	Disch	5m/Mid	A			
21-Apr-88	Disch	5m/Mid	B			
21-Apr-88	Disch	5m/Mid	Combined	0	0	0
21-Apr-88	Disch	5m/Bot	A	1 14.0	0	18 sculpins
21-Apr-88	Disch	5m/Bot	B	3 13.5,14,14	0	14 sculpins
21-Apr-88	Disch	5m/Bot	Combined	4	0	32 sculpins
21-Apr-88	Disch	7m/Surf	A	0	0	0
21-Apr-88	Disch	7m/Surf	B	0	0	0
21-Apr-88	Disch	7m/Surf	Combined	0	0	0
21-Apr-88	Disch	7m/Mid	A			
21-Apr-88	Disch	7m/Mid	B			
21-Apr-88	Disch	7m/Mid	Combined	0	0	0
21-Apr-88	Disch	7m/Bot	A	1 14.5	0	7 sculpins
21-Apr-88	Disch	7m/Bot	B	1 14.0	0	5 sculpins
21-Apr-88	Disch	7m/Bot	Combined	2	0	12 sculpins
21-Apr-88	Disch	10m/Surf	A	0	0	0
21-Apr-88	Disch	10m/Surf	B	0	0	0
21-Apr-88	Disch	10m/Surf	Combined	0	0	0
21-Apr-88	Disch	10m/Mid	A			
21-Apr-88	Disch	10m/Mid	B			
21-Apr-88	Disch	10m/Mid	Combined	0	0	0
21-Apr-88	Disch	10m/Bot	A	0	0	15 sculpins
21-Apr-88	Disch	10m/Bot	B	0	0	14 sculpins
21-Apr-88	Disch	10m/Bot	Combined	0	0	29 sculpins
21-Apr-88	Disch	12m/Surf	A	0	0	0
21-Apr-88	Disch	12m/Surf	B	0	0	0
21-Apr-88	Disch	12m/Surf	Combined	0	0	0
21-Apr-88	Disch	12m/Mid	A			
21-Apr-88	Disch	12m/Mid	B			
21-Apr-88	Disch	12m/Mid	Combined	0	0	0
21-Apr-88	Disch	12m/Bot	A	0	0	9 sculpins
21-Apr-88	Disch	12m/Bot	B	0	0	5 sculpins
21-Apr-88	Disch	12m/Bot	Combined	0	0	14 sculpins

APPENDIX 4 CONTINUED

DARLINGTON 1988 LARVAL FISH CATCH DATA

DATE	LOCATION	DEPTH	NET	RWF	SHELT	OTHERS
26-Apr-88	Intake	5m/Surf	A	0	0	0
26-Apr-88	Intake	5m/Surf	B	0	0	0
26-Apr-88	Intake	5m/Surf	Combined	0	0	0
26-Apr-88	Intake	5m/Mid	A			
26-Apr-88	Intake	5m/Mid	B			
26-Apr-88	Intake	5m/Mid	Combined	0	0	0
26-Apr-88	Intake	5m/Bot	A	1 15.0	0	7 sculpins
26-Apr-88	Intake	5m/Bot	B	0	0	0
26-Apr-88	Intake	5m/Bot	Combined	1	0	7 sculpins
26-Apr-88	Intake	7m/Surf	A	0	0	0
26-Apr-88	Intake	7m/Surf	B	0	0	0
26-Apr-88	Intake	7m/Surf	Combined	0	0	0
26-Apr-88	Intake	7m/Mid	A			
26-Apr-88	Intake	7m/Mid	B			
26-Apr-88	Intake	7m/Mid	Combined	0	0	0
26-Apr-88	Intake	7m/Bot	A	0	0	11 sculpins
26-Apr-88	Intake	7m/Bot	B	0	0	11 sculpins
26-Apr-88	Intake	7m/Bot	Combined	0	0	22 sculpins
26-Apr-88	Intake	10m/Surf	A	0	0	0
26-Apr-88	Intake	10m/Surf	B	0	0	0
26-Apr-88	Intake	10m/Surf	Combined	0	0	0
26-Apr-88	Intake	10m/Mid	A			
26-Apr-88	Intake	10m/Mid	B			
26-Apr-88	Intake	10m/Mid	Combined	0	0	0
26-Apr-88	Intake	10m/Bot	A	0	0	7 sculpins
26-Apr-88	Intake	10m/Bot	B	0	0	3 sculpins
26-Apr-88	Intake	10m/Bot	Combined	0	0	10 sculpins
26-Apr-88	Intake	12m/Surf	A	0	0	0
26-Apr-88	Intake	12m/Surf	B	0	0	0
26-Apr-88	Intake	12m/Surf	Combined	0	0	0
26-Apr-88	Intake	12m/Mid	A			
26-Apr-88	Intake	12m/Mid	B			
26-Apr-88	Intake	12m/Mid	Combined	0	0	0
26-Apr-88	Intake	12m/Bot	A	0	0	7 sculpins
26-Apr-88	Intake	12m/Bot	B	0	0	10 sculpins
26-Apr-88	Intake	12m/Bot	Combined	0	0	17 sculpins

APPENDIX 4 CONTINUED

DARLINGTON 1988 LARVAL FISH CATCH DATA

DATE	LOCATION	DEPTH	NET	RWF	SHELT	OTHERS
26-Apr-88	Disch	5m/Surf	A	0	0	0
26-Apr-88	Disch	5m/Surf	B	0	0	0
26-Apr-88	Disch	5m/Surf	Combined	0	0	0
26-Apr-88	Disch	5m/Mid	A			
26-Apr-88	Disch	5m/Mid	B			
26-Apr-88	Disch	5m/Mid	Combined	0	0	0
26-Apr-88	Disch	5m/Bot	A	2 15,15.5	0	7 sculpins
26-Apr-88	Disch	5m/Bot	B	0	0	4 sculpins
26-Apr-88	Disch	5m/Bot	Combined	2	0	11 sculpins
26-Apr-88	Disch	7m/Surf	A	0	0	0
26-Apr-88	Disch	7m/Surf	B	0	0	0
26-Apr-88	Disch	7m/Surf	Combined	0	0	0
26-Apr-88	Disch	7m/Mid	A			
26-Apr-88	Disch	7m/Mid	B			
26-Apr-88	Disch	7m/Mid	Combined	0	0	0
26-Apr-88	Disch	7m/Bot	A	0	0	0
26-Apr-88	Disch	7m/Bot	B	0	0	2 sculpins
26-Apr-88	Disch	7m/Bot	Combined	0	0	2 sculpins
25-Apr-88	Disch	10m/Surf	A	0	0	0
25-Apr-88	Disch	10m/Surf	B	0	0	0
25-Apr-88	Disch	10m/Surf	Combined	0	0	0
25-Apr-88	Disch	10m/Mid	A			
25-Apr-88	Disch	10m/Mid	B			
25-Apr-88	Disch	10m/Mid	Combined	0	0	0
25-Apr-88	Disch	10m/Bot	A	0	0	0
25-Apr-88	Disch	10m/Bot	B	0	0	0
25-Apr-88	Disch	10m/Bot	C	0	0	1 sculpin
25-Apr-88	Disch	10m/Bot	D	0	0	2 sculpins
25-Apr-88	Disch	10m/Bot	Combined	0	0	3 sculpins
25-Apr-88	Disch	12m/Surf	A	0	0	0
25-Apr-88	Disch	12m/Surf	B	0	0	0
25-Apr-88	Disch	12m/Surf	Combined	0	0	0
25-Apr-88	Disch	12m/Mid	A			
25-Apr-88	Disch	12m/Mid	B			
25-Apr-88	Disch	12m/Mid	Combined	0	0	0
25-Apr-88	Disch	12m/Bot	A	0	0	2 sculpins
25-Apr-88	Disch	12m/Bot	B	0	0	0
25-Apr-88	Disch	12m/Bot	C	0	0	0
25-Apr-88	Disch	12m/Bot	D	0	0	1 sculpin
25-Apr-88	Disch	12m/Bot	Combined	0	0	3 sculpins

APPENDIX 4 CONTINUED
DARLINGTON 1988 LARVAL FISH CATCH DATA

DATE	LOCATION	DEPTH	NET	RWF	SHELT	OTHERS
28-Apr-88	Intake	5m/Surf	A			
28-Apr-88	Intake	5m/Surf	B			
28-Apr-88	Intake	5m/Surf	Combined	0	0	0
28-Apr-88	Intake	5m/Mid	A	0	0	0
28-Apr-88	Intake	5m/Mid	B	0	0	0
28-Apr-88	Intake	5m/Mid	Combined	0	0	0
28-Apr-88	Intake	5m/Bot	A	1 16,17	0	9 sculpins
28-Apr-88	Intake	5m/Bot	B	1	0	9 sculpins
28-Apr-88	Intake	5m/Bot	Combined	2	0	18 sculpins
28-Apr-88	Intake	7m/Surf	A			
28-Apr-88	Intake	7m/Surf	B			
28-Apr-88	Intake	7m/Surf	Combined	0	0	0
28-Apr-88	Intake	7m/Mid	A	0	0	0
28-Apr-88	Intake	7m/Mid	B	0	0	0
28-Apr-88	Intake	7m/Mid	Combined	0	0	0
28-Apr-88	Intake	7m/Bot	A	0	0	13 sculpins
28-Apr-88	Intake	7m/Bot	B	0	0	17 sculpins
28-Apr-88	Intake	7m/Bot	Combined	0	0	30 sculpins
28-Apr-88	Intake	10m/Surf	A			
28-Apr-88	Intake	10m/Surf	B			
28-Apr-88	Intake	10m/Surf	Combined	0	0	0
28-Apr-88	Intake	10m/Mid	A	0	0	0
28-Apr-88	Intake	10m/Mid	B	0	0	0
28-Apr-88	Intake	10m/Mid	Combined	0	0	0
28-Apr-88	Intake	10m/Bot	A	0	0	15 sculpins
28-Apr-88	Intake	10m/Bot	B	0	0	17 sculpins
28-Apr-88	Intake	10m/Bot	Combined	0	0	32 sculpins
28-Apr-88	Intake	12m/Surf	A			
28-Apr-88	Intake	12m/Surf	B			
28-Apr-88	Intake	12m/Surf	Combined	0	0	0
28-Apr-88	Intake	12m/Mid	A	0	0	0
28-Apr-88	Intake	12m/Mid	B	0	0	0
28-Apr-88	Intake	12m/Mid	Combined	0	0	0
28-Apr-88	Intake	12m/Bot	A	0	0	17 sculpins
28-Apr-88	Intake	12m/Bot	B	0	0	5 sculpins
28-Apr-88	Intake	12m/Bot	Combined	0	0	22 sculpins

APPENDIX 4 CONTINUED

DARLINGTON 1988 LARVAL FISH CATCH DATA

DATE	LOCATION	DEPTH	NET	RWF	SHELT	OTHERS
28-Apr-88	Disch	5m/Surf	A			
28-Apr-88	Disch	5m/Surf	B			
28-Apr-88	Disch	5m/Surf	Combined	0	0	0
28-Apr-88	Disch	5m/Mid	A	0	0	0
28-Apr-88	Disch	5m/Mid	B	0	0	0
28-Apr-88	Disch	5m/Mid	Combined	0	0	0
28-Apr-88	Disch	5m/Bot	A	5 16,16.5,17	0	10 sculpins
28-Apr-88	Disch	5m/Bot	B	2 17.5,18	0	21 sculpins
28-Apr-88	Disch	5m/Bot	Combined	7	0	31 sculpins
28-Apr-88	Disch	7m/Surf	A			
28-Apr-88	Disch	7m/Surf	B			
28-Apr-88	Disch	7m/Surf	Combined	0	0	0
28-Apr-88	Disch	7m/Mid	A	0	0	0
28-Apr-88	Disch	7m/Mid	B	0	0	0
28-Apr-88	Disch	7m/Mid	Combined	0	0	0
28-Apr-88	Disch	7m/Bot	A	1 15.5	0	20 sculpins
28-Apr-88	Disch	7m/Bot	B	0	0	5 sculpins
28-Apr-88	Disch	7m/Bot	Combined	1	0	25 sculpins
28-Apr-88	Disch	10m/Surf	A			
28-Apr-88	Disch	10m/Surf	B			
28-Apr-88	Disch	10m/Surf	Combined	0	0	0
28-Apr-88	Disch	10m/Mid	A	0	0	0
28-Apr-88	Disch	10m/Mid	B	0	0	0
28-Apr-88	Disch	10m/Mid	Combined	0	0	0
28-Apr-88	Disch	10m/Bot	A	0	0	0
28-Apr-88	Disch	10m/Bot	B	0	0	18 sculpins
28-Apr-88	Disch	10m/Bot	Combined	0	0	18 sculpins
28-Apr-88	Disch	12m/Surf	A			
28-Apr-88	Disch	12m/Surf	B			
28-Apr-88	Disch	12m/Surf	Combined	0	0	0
28-Apr-88	Disch	12m/Mid	A	0	0	0
28-Apr-88	Disch	12m/Mid	B	0	0	0
28-Apr-88	Disch	12m/Mid	Combined	0	0	0
28-Apr-88	Disch	12m/Bot	A	0	0	9 sculpins
28-Apr-88	Disch	12m/Bot	B	0	0	1 sculpin
28-Apr-88	Disch	12m/Bot	Combined	0	0	10 sculpins

APPENDIX 4 CONTINUED

DARLINGTON 1988 LARVAL FISH CATCH DATA

DATE	LOCATION	DEPTH	NET	RWF	SHELT	OTHERS
02-May-88	Intake	5m/Surf	A			
02-May-88	Intake	5m/Surf	B			
02-May-88	Intake	5m/Surf	Combined	0	0	0
04-May-88	Intake	5m/Mid	A	0	0	0
04-May-88	Intake	5m/Mid	B	0	0	0
04-May-88	Intake	5m/Mid	Combined	0	0	0
04-May-88	Intake	5m/Bot	A	4 14,14,14.5	0	59 sculpins
04-May-88	Intake	5m/Bot	B	0	0	1 sculpin
04-May-88	Intake	5m/Bot	Combined	4	0	60 sculpins
02-May-88	Intake	7m/Surf	A	0	0	0
02-May-88	Intake	7m/Surf	B	0	0	0
02-May-88	Intake	7m/Surf	Combined	0	0	0
02-May-88	Intake	7m/Mid	A			
02-May-88	Intake	7m/Mid	B			
02-May-88	Intake	7m/Mid	Combined	0	0	0
02-May-88	Intake	7m/Bot	A	0	0	1 sculpin
02-May-88	Intake	7m/Bot	B	0	0	1 sculpin
02-May-88	Intake	7m/Bot	Combined	0	0	2 sculpins
02-May-88	Intake	10m/Surf	A	0	0	0
02-May-88	Intake	10m/Surf	B	0	0	0
02-May-88	Intake	10m/Surf	Combined	0	0	0
02-May-88	Intake	10m/Mid	A			
02-May-88	Intake	10m/Mid	B			
02-May-88	Intake	10m/Mid	Combined	0	0	0
02-May-88	Intake	10m/Bot	A	0	0	4 sculpins
02-May-88	Intake	10m/Bot	B	0	0	0
02-May-88	Intake	10m/Bot	Combined	0	0	4 sculpins
02-May-88	Intake	12m/Surf	A	0	0	0
02-May-88	Intake	12m/Surf	B	0	0	0
02-May-88	Intake	12m/Surf	Combined	0	0	0
02-May-88	Intake	12m/Mid	A			
02-May-88	Intake	12m/Mid	B			
02-May-88	Intake	12m/Mid	Combined	0	0	0
02-May-88	Intake	12m/Bot	A	0	0	0
02-May-88	Intake	12m/Bot	B	0	0	0
02-May-88	Intake	12m/Bot	Combined	0	0	0

APPENDIX 4 CONTINUED
DARLINGTON 1988 LARVAL FISH CATCH DATA

DATE	LOCATION	DEPTH	NET	RWF	SMELT	OTHERS	
02-May-88	Disch	5m/Surf	A				
02-May-88	Disch	5m/Surf	B				
02-May-88	Disch	5m/Surf	Combined	0	0	0	
04-May-88	Disch	5m/Mid	A	0	0	0	
04-May-88	Disch	5m/Mid	B	0	0	0	
04-May-88	Disch	5m/Mid	Combined	0	0	0	
04-May-88	Disch	5m/Bot	A	2 17,18	0	5 sculpins	
04-May-88	Disch	5m/Bot	B	3 16.5,17,17	0	21 sculpins	
04-May-88	Disch	5m/Bot	Combined	5	0	26 sculpins	
02-May-88	Disch	7m/Surf	A				
02-May-88	Disch	7m/Surf	B				
02-May-88	Disch	7m/Surf	Combined	0	0	0	
04-May-88	Disch	7m/Mid	A	0	0	0	
04-May-88	Disch	7m/Mid	B	0	0	0	
04-May-88	Disch	7m/Mid	Combined	0	0	0	
02-May-88	Disch	7m/Bot	A	2 16.5,17	0	0	
02-May-88	Disch	7m/Bot	B	2 17.5,19	1 egg	2 sculpins	
04-May-88	Disch	7m/Bot	C	0	0	29 sculpins	
04-May-88	Disch	7m/Bot	D	4 17,17.5,18	0	94 sculpins	11 sculpin eggs
04-May-88	Disch	7m/Bot	Combined	8	1	125 sculpins	
02-May-88	Disch	10m/Surf	A				
02-May-88	Disch	10m/Surf	B				
02-May-88	Disch	10m/Surf	Combined	0	0	0	
04-May-88	Disch	10m/Mid	A	0	0	0	
04-May-88	Disch	10m/Mid	B	0	0	0	
04-May-88	Disch	10m/Mid	Combined	0	0	0	
02-May-88	Disch	10m/Bot	A	2 16.5,17	0	15 sculpins	
02-May-88	Disch	10m/Bot	B	3 15,15.5,16	0	53 sculpins	
04-May-88	Disch	10m/Bot	C	0	0	111 sculpins	
04-May-88	Disch	10m/Bot	D	1 18.0	0	51 sculpins	
04-May-88	Disch	10m/Bot	Combined	6	0	230 sculpins	
02-May-88	Disch	12m/Surf	A				
02-May-88	Disch	12m/Surf	B				
02-May-88	Disch	12m/Surf	Combined	0	0	0	
04-May-88	Disch	12m/Mid	A	0	0	0	
04-May-88	Disch	12m/Mid	B	0	0	0	
04-May-88	Disch	12m/Mid	Combined	0	0	0	
02-May-88	Disch	12m/Bot	A	0	0	81 sculpins	
02-May-88	Disch	12m/Bot	B	0	0	77 sculpins	300 perch eggs
04-May-88	Disch	12m/Bot	C	0	0	121 sculpins	
04-May-88	Disch	12m/Bot	D	0	0	14 sculpins	
04-May-88	Disch	12m/Bot	Combined	0	0	293 sculpins	

APPENDIX 4 CONTINUED
DARLINGTON 1988 LARVAL FISH CATCH DATA

DATE	LOCATION	DEPTH	NET	RWF	SHELT	OTHERS
10-May-88	Intake	5m/Surf	A	0	0	0
10-May-88	Intake	5m/Surf	B	0	0	0
10-May-88	Intake	5m/Surf	Combined	0	0	0
10-May-88	Intake	5m/Mid	A			
10-May-88	Intake	5m/Mid	B			
10-May-88	Intake	5m/Mid	Combined	0	0	0
10-May-88	Intake	5m/Bot	A	0	0	15 sculpins
10-May-88	Intake	5m/Bot	B	0	0	14 sculpins
10-May-88	Intake	5m/Bot	Combined	0	0	29 sculpins
10-May-88	Intake	7m/Surf	A	0	1	0
10-May-88	Intake	7m/Surf	B	0	6	0
10-May-88	Intake	7m/Surf	Combined	0	7	0
10-May-88	Intake	7m/Mid	A			
10-May-88	Intake	7m/Mid	B			
10-May-88	Intake	7m/Mid	Combined	0	0	0
10-May-88	Intake	7m/Bot	A	0	0	2 sculpins
10-May-88	Intake	7m/Bot	B	0	0	4 sculpins
10-May-88	Intake	7m/Bot	Combined	0	0	6 sculpins
10-May-88	Intake	10m/Surf	A	0	1	0
10-May-88	Intake	10m/Surf	B	1 12.5	0	30 sculpins, 1 darter
10-May-88	Intake	10m/Surf	Combined	1	1	30 sculpins
10-May-88	Intake	10m/Mid	A			
10-May-88	Intake	10m/Mid	B			
10-May-88	Intake	10m/Mid	Combined	0	0	0
10-May-88	Intake	10m/Bot	A	0	1 egg	33 sculpins
10-May-88	Intake	10m/Bot	B	0	0	31 sculpins,1darter
10-May-88	Intake	10m/Bot	Combined	0	1	64 sculpins
10-May-88	Intake	12m/Surf	A	0	1	0
10-May-88	Intake	12m/Surf	B	0	0	0
10-May-88	Intake	12m/Surf	Combined	0	1	0
10-May-88	Intake	12m/Mid	A			
10-May-88	Intake	12m/Mid	B			
10-May-88	Intake	12m/Mid	Combined	0	0	0
10-May-88	Intake	12m/Bot	A	0	0	35 sculpins
10-May-88	Intake	12m/Bot	B	0	0	38 sculpins
10-May-88	Intake	12m/Bot	Combined	0	0	73 sculpins

APPENDIX 4 CONTINUED

DARLINGTON 1988 LARVAL FISH CATCH DATA

DATE	LOCATION	DEPTH	NET	RMF	SMELT	OTHERS
10-May-88	Disch	5m/Surf	A	0	0	0
10-May-88	Disch	5m/Surf	B	0	3	7 sculpins
10-May-88	Disch	5m/Surf	Combined	0	3	7 sculpins
10-May-88	Disch	5m/Mid	A			
10-May-88	Disch	5m/Mid	B			
10-May-88	Disch	5m/Mid	Combined	0	0	0
10-May-88	Disch	5m/Bot	A	0	0	7 sculpins
10-May-88	Disch	5m/Bot	B	0	0	17 sculpins
10-May-88	Disch	5m/Bot	Combined	0	0	24 sculpins
10-May-88	Disch	7m/Surf	A	0	0	0
10-May-88	Disch	7m/Surf	B	0	0	0
10-May-88	Disch	7m/Surf	Combined	0	0	0
10-May-88	Disch	7m/Mid	A			
10-May-88	Disch	7m/Mid	B			
10-May-88	Disch	7m/Mid	Combined	0	0	0
10-May-88	Disch	7m/Bot	A	0	0	29 sculpins
10-May-88	Disch	7m/Bot	B	0	0	22 sculpins
10-May-88	Disch	7m/Bot	Combined	0	0	51 sculpins
10-May-88	Disch	10m/Surf	A	0	0	0
10-May-88	Disch	10m/Surf	B	0	0	0
10-May-88	Disch	10m/Surf	Combined	0	0	0
10-May-88	Disch	10m/Mid	A			
10-May-88	Disch	10m/Mid	B			
10-May-88	Disch	10m/Mid	Combined	0	0	0
10-May-88	Disch	10m/Bot	A	0	0	2 sculpins
10-May-88	Disch	10m/Bot	B	0	0	47 sculpins
10-May-88	Disch	10m/Bot	Combined	0	0	49 sculpins
10-May-88	Disch	12m/Surf	A	0	0	0
10-May-88	Disch	12m/Surf	B	0	0	0
10-May-88	Disch	12m/Surf	Combined	0	0	0
10-May-88	Disch	12m/Mid	A			
10-May-88	Disch	12m/Mid	B			
10-May-88	Disch	12m/Mid	Combined	0	0	0
10-May-88	Disch	12m/Bot	A	0	0	0
10-May-88	Disch	12m/Bot	B	0	0	2 sculpins
10-May-88	Disch	12m/Bot	Combined	0	0	2 sculpins

APPENDIX 5

CATCHES IN LARVAL DRIFT NETS AT INTAKE LOCATION, 1987

Date	5 Meter Depth		7 Meter Depth	
	East	West	East	West
23-Apr-87	----------Traps Installed----------			
29-Apr-87	0	0	0	0
01-May-87	0	0	0	0
04-May-87	0	0	1 sculpin 49 sculpin eggs	1 sculpin
06-May-87	0	0	0	0
08-May-87	0	0	0	0
12-May-87	0	0	0	0
14-May-87	0	0	0	0
20-May-87	0	0	0	0
22-May-87	0	0	0	0
22-May-87	----------Traps Removed----------			

APPENDIX 6

CATCHES IN LARVAL DRIFT NETS AT DIFFUSER LOCATION, 1988

Date	5 Meter Depth		7 Meter Depth	
	East	West	East	West
29-Apr-88	----------Traps Installed----------			
03-May-88	0	0	1 sculpin	1 sculpin
06-May-88	0	0	0	0
17-May-88	0	1 r. whtfish	1 sculpin	0
17-May-88	----------Traps Removed----------			

APPENDIX 7
ENTRAINMENT TOW NET SAMPLES
ALL SAMPLES TAKEN AT INTAKE LOCATION
SURFACE, MID-DEPTH & BOTTOM

DATE	DEPTH	ALEWIFE	ALEW. EGGS	SMELT	SMELT EGGS	OTHERS
02-Jun-86	Surface	0	0	0	0	0
02-Jun-86	Mid	0	0	0	0	0
02-Jun-86	Bottom	0	0	0	0	0
03-Jun-86	Surface	0	0	2 5.5 mm	0	0
03-Jun-86	Mid	0	0	0	0	0
03-Jun-86	Bottom	0	0	0	0	0
09-Jun-86	Surface	0	0	3 5,5.5,6mm	0	0
09-Jun-86	Mid	0	0	0	0	0
09-Jun-86	Bottom	0	0	0	0	0
10-Jun-86	Surface	0	0	3 5.5,6,6mm	0	2 sculpin eggs
10-Jun-86	Mid	0	0	0	0	0
10-Jun-86	Bottom	0	0	0	0	0
17-Jun-86	Surface	0	0	16 5-6 mm	0	0
17-Jun-86	Mid	0	0	5 5-6 mm	0	0
17-Jun-86	Bottom	0	0	11 5-6 mm	0	0
18-Jun-86	Surface	0	0	8 5-6 mm	0	0
18-Jun-86	Mid	0	0	1	0	0
18-Jun-86	Bottom	0	0	4 5.5-6mm	0	0
25-Jun-86	Surface	0	0	4 5-5.5mm	0	0
25-Jun-86	Mid	0	0	1 5.5 mm	0	0
25-Jun-86	Bottom	0	0	3 5-6 mm	0	0
26-Jun-86	Surface	0	0	2 5.5, 6mm	0	0
26-Jun-86	Mid	0	0	0	0	0
26-Jun-86	Bottom	0	0	1 5.5 mm	0	0
30-Jun-86	Surface	0	0	0	0	0
30-Jun-86	Mid	0	0	0	0	0
30-Jun-86	Bottom	0	0	0	0	0
01-Jul-86	Surface	0	0	0	0	0
01-Jul-86	Mid	0	0	0	0	0
01-Jul-86	Bottom	0	0	0	0	0
07-Jul-86	Surface	0	0	4 5.5-7mm	0	0
07-Jul-86	Mid	0	0	4 8-9 mm	0	0
07-Jul-86	Bottom	0	0	0	0	0

APPENDIX 7 CONTINUED
ENTRAINMENT TOW NET SAMPLES

DATE	DEPTH	ALEWIFE		ALEW. EGGS	SMELT		SMELT EGGS	OTHERS
09-Jul-86	Surface	0		0	3	7,9,9mm	0	0
09-Jul-86	Mid	0		0	1	5 mm	0	0
09-Jul-86	Bottom	0		0	0		0	0
14-Jul-86	Surface	0		0	10	6-18mm	0	0
14-Jul-86	Mid	0		0	2	7,8mm	0	0
14-Jul-86	Bottom	0		0	1	16 mm	0	0
15-Jul-86	Surface	0		0	3	7,8,14mm	0	0
15-Jul-86	Mid	0		0	0		0	0
15-Jul-86	Bottom	0		0	1	6.5 mm	0	0
21-Jul-86	Surface	0		0	0		0	0
21-Jul-86	Mid	0		0	0		0	0
21-Jul-86	Bottom	0		0	0		0	0
22-Jul-86	Surface	139	4-5 mm	0	0		0	6 carp (5-5.5mm)
22-Jul-86	Mid	3	4.5 mm	0	0		0	0
22-Jul-86	Bottom	2	4.5 mm	0	0		0	0
30-Jul-86	Surface	29	4-6.5mm	144	0		0	0
30-Jul-86	Mid	10	4-5 mm	91	0		0	0
30-Jul-86	Bottom	14	4.5-5mm	60	0		0	0
31-Jul-86	Surface	126	4.5-8.5mm	0	0		0	0
31-Jul-86	Mid	8	3.5-8.5mm	1	0		0	0
31-Jul-86	Bottom	13	3.5-8mm	1	0		0	0
05-Aug-86	Surface	9	3.5-5mm	0	0		0	0
05-Aug-86	Mid	4	4-5 mm	0	0		0	0
05-Aug-86	Bottom	51	3.5-21mm	0	1	32 mm	0	1 sculpin 32mm
06-Aug-86	Surface	1	4.5 mm	0	0		0	0
06-Aug-86	Mid	16	3.5-5.5,13	0	2	28,33 mm	0	0
06-Aug-86	Bottom	29	4-5.5 mm	0	1	32 mm	0	0
13-Aug-86	Surface	1	4.0 mm	2	0		0	0
13-Aug-86	Mid	0		0	0		0	0
13-Aug-86	Bottom	0		1	0		0	0
14-Aug-86	Surface	0		0	0		0	0
14-Aug-86	Mid	0		0	0		0	0
14-Aug-86	Bottom	2	5,5.5mm	0	0		0	0

APPENDIX 8

DAR 87 RWF EGG INCUBATIONS

WEST SITE Rep #1

Date	L.eggs	D.eggs	L.larv	D.larv	%Surv	Dev.Stage
16-Dec-86	150	0	0	0	100.00	0
20-Jan-87	133	16	0	0	88.67	9.5
16-Feb-87	125	17	0	0	83.33	14.8
24-Mar-87	60	27	0	0	40.00	18.5
07-Apr-87	85	3	5	0	60.00	19.25
13-Apr-87	4	13	3	11	4.67	20

INSHORE DIFFUSER Rep #1

Date	L.eggs	D.eggs	L.larv	D.larv	%Surv	Dev.Stage
16-Dec-86	150	0	0	0	100.00	0
20-Jan-87	129	18	0	0	86.00	9
16-Feb-87	117	16	0	0	78.00	14.5
24-Mar-87	65	30	0	1	43.33	18.25
07-Apr-87	88	3	0	0	58.67	19
13-Apr-87	11	2	47	17	38.67	20

OFFSHORE DIFFUSER Rep #1

Date	L.eggs	D.eggs	L.larv	D.larv	%Surv	Dev.Stage
16-Dec-86	150	0	0	0	100.00	0
20-Jan-87	124	21	0	0	82.67	9.75
16-Feb-87	101	5	0	0	67.33	16
24-Mar-87	119	5	0	0	79.33	19
07-Apr-87	75	1	1	3	50.67	19
13-Apr-87	8	3	13	33	14.00	20

EAST SITE Rep #1

Date	L.eggs	D.eggs	L.larv	D.larv	%Surv	Dev.Stage
16-Dec-86	150	0	0	0	100.00	0
20-Jan-87	134	19	0	0	87.58	9
16-Feb-87	116	10	0	0	77.33	14.5
24-Mar-87	97	13	0	0	64.67	18.5
07-Apr-87	95	5	1	1	64.00	19
13-Apr-87	15	12	12	17	18.00	20

APPENDIX 8 CONTINUED
DARLINGTON 86/87 RWF EGG INCUBATIONS

WEST SITE Rep #2

Date	L.eggs	D.eggs	L.larv	D.larv	%Surv	Dev.Stage	Avg% Surv	Avg.Dev	Dev.Days
16-Dec-86	150	0	0	0	100.00	0	100.00	0	0
20-Jan-87	115	22	0	0	76.67	9.5	82.67	9.5	35
16-Feb-87	122	3	0	0	81.33	14.5	82.33	14.65	62
24-Mar-87	67	27	0	0	44.67	18.25	42.33	18.375	98
07-Apr-87	98	1	1	0	66.00	19	63.00	19.125	112
13-Apr-87	1	6	7	8	5.33	20	5.00	20	118

INSHORE DIFFUSER Rep #2

Date	L.eggs	D.eggs	L.larv	D.larv	%Surv	Dev.Stage	Avg% Surv	Avg.Dev	Dev.Days
16-Dec-86	150	0	0	0	100.00	0	100.00	0	0
20-Jan-87	137	13	0	0	91.33	9	88.67	9	35
16-Feb-87	103	30	0	0	68.67	14.5	73.33	14.5	62
24-Mar-87	100	11	0	0	66.67	18	55.00	18.125	98
07-Apr-87	38	9	1	3	26.00	19	42.33	19	112
13-Apr-87	5	6	1	14	4.00	20	21.33	20	118

OFFSHORE DIFFUSER Rep #2

Date	L.eggs	D.eggs	L.larv	D.larv	%Surv	Dev.Stage	Avg% Surv	Avg.Dev	Dev.Days
16-Dec-86	150	0	0	0	100.00	0	100.00	0	0
20-Jan-87	122	20	0	0	81.33	9.75	82.00	9.75	35
16-Feb-87	129	5	0	0	86.00	16	76.67	16	62
24-Mar-87	99	13	0	0	66.00	18.75	72.67	18.875	98
07-Apr-87	76	5	0	2	50.67	19.25	50.67	19.125	112
13-Apr-87	16	8	17	44	22.00	20	18.00	20	118

EAST SITE Rep #2

Date	L.eggs	D.eggs	L.larv	D.larv	%Surv	Dev.Stage	Avg% Surv	Avg.Dev	Dev.Days
16-Dec-86	150	0	0	0	100.00	0	100.00	0	0
20-Jan-87	130	27	0	0	82.80	9	85.19	9	35
16-Feb-87	103	11	0	0	68.67	14.5	73.00	14.5	62
24-Mar-87	118	4	0	0	78.67	18	71.67	18.25	98
07-Apr-87	118	2	0	3	78.67	19	71.33	19	112
13-Apr-87	22	1	27	6	32.67	20	25.33	20	118

APPENDIX 9
DARLINGTON 86/87 RMF EGG INCUBATIONS - SEDIMENT DATA

CHAMBER SEDIMENT WEST

Date	Pan	S400	S230	S170	S60	S35	Total
16-Dec-86	0	0	0	0	0	0	0
20-Jan-87	2.1534	2.52	0.8461	3.7792	5.7079	0.001	15.0076
16-Feb-87	7.2086	7.9906	3.5698	26.0031	29.8217	22.1543	96.7481
24-Mar-87	8.0628	7.9758	7.1141	26.354	37.6953	30.3816	117.5836
07-Apr-87	9.2185	10.0441	6.4177	13.1006	19.5784	12.2769	70.6362
13-Apr-87	23.832	21.388	21.4839	53.3015	70.7664	35.7911	226.5629

CHAMBER SEDIMENT INSHORE DIFFUSER

Date	Pan	S400	S230	S170	S60	S35	Total
16-Dec-86	0	0	0	0	0	0	0
20-Jan-87	0.7875	1.192	0.424	3.4801	14.3446	0.001	20.2292
16-Feb-87	8.2428	7.8664	5.1745	21.2881	90.4663	26.4446	159.4827
24-Mar-87	9.6478	7.6359	4.7351	27.7265	116.0657	55.5551	221.3661
07-Apr-87	12.7791	17.3948	7.5102	32.9156	97.8721	16.8573	185.3291
13-Apr-87	10.3642	11.1459	11.1424	30.5647	72.1214	8.3354	143.674

CHAMBER SEDIMENT OFFSHORE DIFFUSER

Date	Pan	S400	S230	S170	S60	S35	Total
16-Dec-86	0	0	0	0	0	0	0
20-Jan-87	1.5505	2.3538	0.946	4.5723	1.3887	0.001	10.8123
16-Feb-87	1.7185	2.3646	1.3316	11.0912	4.2225	0.4055	21.1339
24-Mar-87	2.1145	3.2998	1.4416	15.1218	6.0163	0.45653	28.45053
07-Apr-87	3.388	4.5176	4.1756	18.2438	28.6937	0.4948	59.5135
13-Apr-87	11.8365	11.8179	7.2131	26.6771	39.2509	0.7871	96.7826

CHAMBER SEDIMENT EAST

Date	Pan	S400	S230	S170	S60	S35	Total
16-Dec-86	0	0	0	0	0	0	0
20-Jan-87	2.0908	2.4947	0.5349	2.5938	0.9908	0.001	8.706
16-Feb-87	2.112	1.3682	0.9547	5.8739	3.1679	0.001	13.4777
24-Mar-87	4.0832	7.7634	1.8325	13.4614	6.8022	0.7938	34.7365
07-Apr-87	12.3551	16.4322	10.8771	39.8819	53.4044	1.4157	134.3664
13-Apr-87	14.7892	17.9785	7.4882	36.3502	48.7723	1.5805	126.9589

-Values are in grams dry weight
-Particle sizes are as follows:
Pan: <38 microns
S400: 38 to 63 microns
S230: 63 to 125 microns
S170: 125 to 250 microns
S60: 250 to 500 microns
S35: 500 to 1000 microns

APPENDIX 10
ROUND WHITEFISH EGG MORTALITY - DATA ANALYSIS AND PREDICTIONS
COMPARISON OF OBSERVED & PREDICTED RESULTS

WEST	ObsDev	PredDev	Obs % Surv	PredSurv	Excess Mort	PredSurv*
16-Dec-86	0	0	100.00	100	0	100
20-Jan-87	9.5	8.12	82.67	92.87	10.203333	80.981
16-Feb-87	14.65	11.8	82.33	91.09	8.7566666	67.432
24-Mar-87	18.375	16.8	42.33	89.54	47.206666	63.894
07-Apr-87	19.125	19.07	63.00	88.95	25.95	60.613
13-Apr-87	20	19.22	5.00	87.51	54.83	25.153
21-Apr-87	-	19.5		77.05		0
07-May-87	-	20		59.83		

DIFF IN	ObsDev	PredDev	Obs % Surv	PredSurv	Excess Mort	PredSurv*
16-Dec-86	0	0	100.00	100	0	100
20-Jan-87	9	8.7	88.67	92.01	3.3433333	83.3
16-Feb-87	14.5	12.28	73.33	90.75	17.416666	64.684
24-Mar-87	18.125	17.3	55.00	89.2	34.2	59.863
07-Apr-87	19	19.11	42.33	88.75	46.416666	52.124
13-Apr-87	20	19.27	21.33	87.13	38.596666	56.126
20-Apr-87	-	19.52		77.56		28.926
05-May-87	-	20		59.93		

DIFF OFF	ObsDev	PredDev	Obs % Surv	PredSurv	Excess Mort	PredSurv*
16-Dec-86	0	0	100.00	100	0	100
20-Jan-87	9.75	9.44	82.00	91.35	9.35	80.684
16-Feb-87	16	13.18	76.67	90.2	13.533333	79.323
24-Mar-87	18.875	18.33	72.67	88.7	16.033333	76.901
07-Apr-87	19.125	19.22	50.67	88.38	37.713333	73.616
13-Apr-87	20	19.36	18.00	87.08	52.11	52.648
18-Apr-87	-	19.54		83.67		35.678
05-May-87	-	20		70.11		

EAST	ObsDev	PredDev	Obs % Surv	PredSurv	Excess Mort	PredSurv*
16-Dec-86	0	0	100.00	100	0	100
20-Jan-87	9	7.84	85.19	93.15	7.9578784	81.406
16-Feb-87	14.5	11.58	73.00	91.23	18.23	79.437
24-Mar-87	18.25	16.6	71.67	89.68	18.013333	73.298
07-Apr-87	19	19.05	71.33	89.11	17.776666	53.471
13-Apr-87	20	19.2	25.33	87.49	32.716666	46.184
22-Apr-87	-	19.51		75.33		16.744
07-May-87	-	20		58.05		

PredDev = Predicted Development Based on Thermal Models
PredSurv = Predicted Survival Based on Thermal Models
PredSurv* = Predicted Survival Based on Thermal Models + Excess Mort Regression + Mean Hatch Date

APPENDIX 10 CONTINUED
ANALYSIS OF EXCESS MORTALITY DATA

REGRESSIONS: EXCESS MORTALITY vs SEDIMENTS IN INCUBATORS

Excess Mortality vs Total Sediment

Regression Output:

Constant	7.6783566
Std Err of Y Est	11.621114
R Squared	0.5836863
No. of Observations	24
Degrees of Freedom	22
X Coefficient(s)	0.1820058
Std Err of Coef.	0.0327713

Excess Mortality vs Fines (pan)

Regression Output:

Constant	6.8762890
Std Err of Y Est	10.742291
R Squared	0.6442712
No. of Observations	24
Degrees of Freedom	22
X Coefficient(s)	2.3279981
Std Err of Coef.	0.3688046

Excess Mortality vs Fines(Pan+#400 seive)

Regression Output:

Constant	6.6005417
Std Err of Y Est	11.108860
R Squared	0.6195793
No. of Observations	24
Degrees of Freedom	22
X Coefficient(s)	1.1241294
Std Err of Coef.	0.1877969

Excess Mortality vs Fines(pan+#400+#230)

Regression Output:

Constant	6.9862933
Std Err of Y Est	10.893040
R Squared	0.6342171
No. of Observations	24
Degrees of Freedom	22
X Coefficient(s)	0.8192441
Std Err of Coef.	0.1326461

APPENDIX 10 CONTINUED

MULTIPLE REGRESSION: EXCESS MORTALITY vs ALL SEDIMENT COMPONENTS (SMALL TO LARGE)

Regression Output:

Constant	6.0917639					
Std Err of Y Est	11.640274					
R Squared	0.6772414					
No. of Observations	24					
Degrees of Freedom	17					
X Coefficient(s)	2.4378984	-1.553288	0.1099214	0.5068636	0.0977198	-0.164543
Std Err of Coef.	2.7289407	2.1341639	1.7196430	0.6288304	0.1460428	0.3327339